Knowledge Traditions and Practices of India

Part I

TEXTBOOK FOR CLASS XI

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विद्यया ऽमृतमश्नुते

एन सी ई आर टी
NCERT

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Foreword

India is a culturally rich country and known for its civilisation and cultural diversity all over the world. This diversity is reflected in the philosophies, customs, literatures, art forms, crafts and health related practices all over India. In India, people's beliefs, ways of life and their understanding of social relationships are quite distinct from one another. Yet they all have equal rights to coexist and flourish, and the education system is expected to respond to the cultural pluralism inherent in our society.

The *National Curriculum Framework*-2005 brought out by the NCERT emphasises upon strengthening of our cultural heritage and national identity. It clearly states that the curriculum should enable the younger generation to reinterpret and reevaluate the past with reference to new priorities and emerging outlooks of a changing societal context. Understanding human evolution should make it clear that the existence of distinctness in our country is a tribute to the special spirit of our country, which allowed it to flourish. The cultural diversity of this land should continue to be treasured as our special attribute.

In consonance with this perspective of NCF-2005, the NCERT has provided ample space to cultural and knowledge practices of our country in an integrated manner across textbooks of different subject areas and classes. However, while reviewing its textbooks in 2017–18 as per the suggestions received from the teachers through online mode, we at NCERT, felt that there is a huge expectation of stakeholders from the NCERT for providing more and more space to the Indian culture and practices for students at the higher stages of school education. This expectation led NCERT to explore a new subject area for Knowledge, Traditions and Practices of India for developing its curricular material. I must acknowledge the vision and continuous guidance of our then Hon'ble Human Resource Development Minister and President, NCERT, Shri Prakash Javadekar, because of him, NCERT could develop this learner-friendly material based on scientific evidences.

It is necessary to mention here, this subject has already been introduced by the Central Board of Secondary Education in 2012 at the Higher Secondary Stage as an elective subject. To avoid any confusion among students regarding the very title of the subject, NCERT has initiated the process of development of textbooks for Higher Secondary Stage with the title 'Knowledge, Traditions and Practices of India'.

This textbook for Class XI contains nine chapters on nine different knowledge traditions and practices — Literature, Crafts, Mathematics, Metallurgy, Ayurveda, Yoga, Philosophy, Astronomy and Performing Arts with a brief introduction of all of these aspects.

The textbook has been developed keeping all the five guiding principles of the NCF-2005 in view. It provides space for students to share their experiences, critical thinking, reflection and decision-making. It has inbuilt evaluation exercises and it presents content in a manner which creates curiosity and interest among children and encourage understanding within their own context, rather than focusing on rote methods.

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This textbook is a result of team work of the faculty members of the NCERT, who have worked very hard to use authentic sources for the writing of this textbook under the able guidance of the Review Committee set up to review the textbooks developed by the NCERT. This textbook has also gone through a massive review by the experts in the specific knowledge areas from various other institutions and took the present shape. I acknowledge the support of all who have contributed towards the development of this textbook.

NCERT would welcome suggestions from students, teachers and parents, which will help us to further improve the quality of the material in subsequent editions.

HRUSHIKESH SENAPATY
Director
National Council of Educational
Research and Training

New Delhi
September, 2019

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An Introduction to Knowledge Traditions and Practices of India

India has a rich variegated history and an extraordinarily complex cultural diversity. If we look closely at our multiple cultures spread across the different regions of the country, we feel proud of the rich repository of our ancient systems of knowledge and traditions in different and diverse fields. This adds to our rich cultural heritage that has translated into practices for survival, sustenance and for leading a healthy and purposeful life. The knowledge and traditions have been handed down to us mainly in the form of oral traditions, textual materials, inscriptions, numismatics, tangible and intangible forms of art and architecture.

Ancient systems of knowledge in India, basically consist of understanding the mysteries of the universe, human interactions with environment, philosophy of life, importance of conservation and preservation of environment, development of art and aesthetic sensitivities and inculcation of just and humane qualities among all. The glimpses of our past have been woven in fields like — philosophy, grammar, literature, economy, agriculture, polity, medicine, yoga, astronomy, astrology, life-sciences, arts and crafts, architecture, metallurgy, mining, gemology, shipbuilding, trade, commerce and many other fields.

In order to provide scope to young learners to reflect upon the rich cultural past of our country, and to link with present cultural practices, a 2-year course on Knowledge, Traditions and Practices has been created. The course is presented in two parts. This textbook is the first part of the course, which acquaints the young learners with the contribution made by India to the knowledge system of the entire world creating landmarks in the area of Mathematics, Astronomy, Metallurgy, Philosophy, Ayurveda, Arts, Yoga, and Language Education. The textbook part II for Class XII students will elaborate more upon arts and crafts of India, language and grammar and will also focus on India's contributions in fields like agriculture, architecture, dance, education system and practices, ethics, martial arts and traditions, technologies, society, state and polity, and commerce. These textbooks will be helpful in developing pride and sense of appreciation for India's culture and heritage, while getting acquainted with the indigenous knowledge.

A brief summary of various chapters covered in this textbook is given here to summarise how various knowledge, traditions and practices evolved in India and how they are being passed from generation to generation.

Language is one of the most beautiful and intriguing phenomenon in the world. Languages represent multitude of people and their lived experiences. This diversity is an outcome of many factors that shape life on the subcontinent. Its territorial space is marked by mountains, river basins, coastlines, dense forests and deserts. This wide topographical range harbours a variety of environmental conditions which influence the language and cultures of people living in these regions. Thus, India houses maximum number of written and orally alive languages in the world. It is home to five major language families. These language families are: Indo-Aryan, Dravidian, Austro-Asiatic, Tibeto-Burmese and Semito-Hamitic. Sanskrit language belongs to Indo-European

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group of languages and was gradually standardised and given a highly scientific grammar by Panini, the great grammarian, in about fifth century B.C. Around that time, the people spoke a number of dialects which are called Prakrits. Gautam Buddha also preached in the language of the people, i.e., Pali, one of the Prakrits. The spoken languages of ancient India formed the basis of modern Indian language developed in various regions of India during the medieval period. Language manifests in literature aesthetically taking care of knowledge, traditions and practices. The history of Indian literatures is ancient and vast. It has been an instrument of education since antiquity. *Shruti* and *Smriti literature*, *Sutra literature*, *Jataka tales*, *Panchtantras*, *Kathasaritsagara*, *Thirukural*, *Athichudi* and *Vachanas* are examples of traditions of literature which have enriched human life encouraging them to follow human values, and living in harmony with nature. Language diversity, as a strong resource, has been contributing to formal and informal education in India since ancient time. Language as a medium of education has contributed for the transmitting of knowledge to other generations. The formal education structures that transmitted traditional knowledge were the *Pathshalas* for primary education and *Tols* and *Chatuspathis* for Higher education. The medium of education was Sanskrit in higher centers of learning. The *Tols* were cosmopolitan in nature and welcomed scholars and teachers from different parts of the country. These centers were mainly located in important towns and villages. The students were given education in *Vyakarana* (grammar), *Sahitya* (literature), *Jyotisha* (astrology), *Ganita* (mathematics), *Smriti* (law) and Ayurveda (medicine).

Human being from time immemorial has been thinking about the nature, its veracity, its source and destination. This tendency of enquiry backed with logic takes us to a systematic study which is called philosophy, literally means 'love of wisdom'. Indian culture is an amalgamation of different philosophical and religious sects. Following different faiths, the Indians have been living together with peace and harmony for around three thousand years since there is an inherent harmony among most of the schools of Indian philosophy.

Indian Philosophical thoughts have been traced in perhaps the earliest available literature of the world, i.e., the *Ṛgveda*. It has primarily two sects known as *Āstika* and *Nāstika*, i.e., believer and non-believer of the *Vedas* respectively. *Sāṅkhya*, Yoga, *Nyāya*, *Vaiśeṣika, Mīmāmsā* and *Vedānta* come under the first category since the views of these schools get authenticated by the verbal testimony of the *Vedas*. *Cārvāka*, Buddha and Jaina are the main three proponents of Indian philosophical schools that do not accept Vedic verbal testimony.

There can be no doubt about the fact that the art forms, be it Performing or Visual reflect the thinking process of the society which comprises its people, their habitat, ethos, emotions, the uniqueness of communities, immediate surrounding or environment and the effects of the historical background. It is evident, all art forms are refined expression of its people. Research studies on the lives of people before the Christain Era (BCE) during the ancient Mohenjo–Daro and Harappan Civilisation, have evidence depicting the different types of arts practiced in varied forms and styles. As human beings started exploring life each day, it gave way to creative expressions in daily lives. They danced, sang, enacted stories related to life, painted pictures to celebrate victories or occasions like birth, marriages, etc., created many types of utensils to store food, clothes to cover the body, shelter to live, decorative items to beautify

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lifestyle, etc. To fulfill the basic needs and desires, all tangible and intangible expressions have been refined with the passage of time. These were the expressions that gave birth to varied artistic traditions.

Indian art and architecture is a confluence of different knowledge evolved over the last several thousand years — of mathematics and sciences, technology and philosophy of aesthetics, which also reflects the society, economics and political conditions and architectural designs and motifs of people through ages. Art and architecture are tangible forms of creativity by human race reflected through various paintings, sculptures, monuments and varieties of buildings.

Astronomy is an ancient science, dating back, perhaps to the time when humans came out of caves to live in the open and felt a sense of wonder and awe as they looked at the sky and observed celestial phenomena like the phases of moon, eclipses and appearance of different stars in the sky. In the absence of real understanding, humans wrapped these phenomena in mystery and incorporated them in their myths and religions. India, being a very old civilisation, had a strong tradition of astronomy. *Vedas* and other religious texts speculated upon many important questions of astronomy and cosmology. These included questions related to the origin of the universe, though the discussion was couched in philosophical terms. At the same time there was a lot of activity in practical astronomy which people needed to conduct in their lives in an orderly fashion. For example, people needed to know when rains would come, and they could sow their crops. They also needed to know when they could celebrate marriages, and other ceremonies and festivals. Besides, phenomena like the eclipses and appearance of comets and shooting stars in the sky were believed to bring misfortune to rulers and destruction from wars, natural disasters like floods and earthquakes. Many kings had, in fact, appointed astronomers to keep an eye on the sky and report to them the occurrence of any such astronomical events. Moreover, most people believed in astrology which held that the motion of heavenly bodies and the occurrence of natural phenomena had profound influence on their destiny. So, it was necessary to follow the motion of heavenly bodies and to track events like eclipses.

Thus, the main preoccupations of the astronomers was—(a) devising calendars and reliable time-keeping devices for measuring time; (b) predicting the time of occurrence and duration of astronomical events such as eclipses; (c) noting the time of appearance of certain stars in the sky, and (d) observing the Sun, moon and planets. It is important to note that all these activities required reliable estimates of the distances of the Sun, moon and other astronomical objects, as well as the ability to undertake tedious mathematical calculations. Many important contributions were made in these fields for which due credit has perhaps not been given to Indian astronomers by the Western historians of science.

A look at the works done in mathematics by Indians in the ancient period makes one wonder about these achievements. The discoveries at Mohenjo-Daro reveal that as early as 3,000 B.C., the inhabitants of the land of the Sindhu lived a highly organised life. In fact, they were far advanced than other people of that period. The *Brahmana* literature (2,000 B.C.), which follows the *Vedas*, is partly ritualistic and partly philosophical. We can find in these works, the origins of most of the sciences and arts which have helped to make up the modern civilisation. The culture of the science of mathematics or of any other

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branch of secular knowledge, was not considered to be a hindrance to spiritual knowledge. Importance to the culture of *Gaṇita* (mathematics) is also given by the Jainas. Their religious literature includes *gaṇita anuyoga* (the exposition of the principles of mathematics). The knowledge of *Saṁkhyāna* (literally, 'the science of numbers,' meaning arithmetic and astronomy) is stated to be one of the principal accomplishments of the Jaina priest. In Buddhist literature too, arithmetic (*gaṇana saṁkhyāna*) is regarded as the first and the noblest of the arts. All these will give a fair idea of the importance and value set upon the culture of *gaṇita* in ancient India.

India's contribution to the world of science is not only the discovery of 'zero' and the decimal system, but also the science of Ayurveda, a truly holistic health system encompassing all the aspects of well-being — from physical, physiological and psychological to environmental and ecological health. Literally meaning 'science of life', Ayurveda is a vast treasure house of interesting and contemporarily relevant scientific concepts dealing with health and disease. It is a science which helps optimise one's health enabling a healthy, productive, happy and satisfactory lifespan. While Ayurveda emphasises greatly on preventive and promotive health, its comprehensive approach to treatment is in tune with the increasing interest in systemic approach to disease in modern medicine. Codified ayurveda would be atleast 4000 years old or 1500 years prior to Hippocrates, the father of Western medicine. Ayurveda has its roots in the *vedas*, considered the oldest written-down literature in the world and from which many theories and philosophies have sprung. The systematised science of Ayurveda has resulted from the amalgamation and practical application of these various concepts and doctrines.

Further, India had its own alchemical traditions. This included the knowledge of chemical processes and techniques. Archaeological findings of Harappa and Saraswati sites provide ample proof in favour of advanced knowledge in the field of agriculture, irrigation, architecture, production of metals and their use and trade. The hymns of *Yajurveda* and *Ṛgveda* are unsurpassable proof of the antiquity of India's progress in science. These *Vedas* mention the extraction and processing of metals such as gold, silver, copper, tin, lead, iron and their alloys.

In ancient India, chemistry had various names, i.e., *Rasāyana Śāstra, Rasatantra, Rasakriyā* or *Rasavidyā.* It included metallurgy, medicine, manufacture of cosmetics, glass, dyes, inks etc. Ancient Indians applied that knowledge of chemistry in various walks of life.

Originated in India, Yoga is a science of spiritual evolution. It has now gained its popularity in the west and practice of Yoga is well accepted by the world at large. It encompasses the different fields of our existence such as physical, psychological, social and spiritual. Yoga is understood as *Anuśāsana* (discipline), and it brings discipline in the health habits of human beings by practicing it regularly and following its rules.

After going through this textbook, the students will be able to recognise and retrieve information on knowledge traditions and practices of India from various primary and secondary sources. They will also be able to compare and analyse the developments taking place in India and different parts of the world, create projects, audio-video materials and other resources, and appreciate our contributions.

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ROMANISATION OF INDIAN SOUNDS

(Diacritical Marks)

Devanāgarī	Roman	Example
अ	a	असत्य asatya
आ (ा)	ā	आकाश ākāśa
इ (ि)	i	इच्छा icchā
ई (ी)	ī	ईश्वर īsvara
उ (ु)	u	उन्नति unnati
ऊ (ू)	ū	ऊर्जा ūrjā
ऋ (ृ)	ṛ	ऋषि ṛṣi
ए (े)	e	एक eka
ऐ (ै)	ai	ऐक्य aikya
ओ (ो)	o	ओषधि oṣadhi
औ (ौ)	au	औषध auṣadha
अं (ं)	ṁ	संसार saṁsāra
अः (ः)	ḥ	दुःख duḥkha
क	ka	कर्म karma
ख	kha	खल khala
ग	ga	गहन gahana
घ	gha	घर ghara
ङ	ṅ	वाङ्मय vāṅmaya
च	ca	चक्र cakra
छ	cha	छत्र chatra
ज	ja	जगत् jagat
झ	jha	झर jhara
ञ	ña	ज्ञान (ज् +ञ +आन) jñāna
ट	ṭa	कीट kiṭa
ठ	ṭha	मठ maṭha
ड	ḍa	गरुड़ garuḍa
ढ	ḍha	गूढ़ gūḍha

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ण	ṇa	गुण guṇa
त	ta	तट taṭa
थ	tha	तथा tathā
द	da	दान dāna
ध	dha	धन dhana
न	na	नाम nāma
प	pa	पशु paśu
फ	pha	फल phala
ब	ba	बल bala
भ	bha	भक्ति bhakti
म	ma	ममता mamatā
य	ya	यथा yathā
र	ra	रात्रि rātri
ल	la	लघु laghu
व	va	वस्तु vastu
श	śa	शान्ति śānti
ष	ṣa	मेष meṣa
स	sa	सुख sukha
ह	ha	हास hāsa

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THE CONSTITUTION OF INDIA

PREAMBLE

WE, THE PEOPLE OF INDIA, having solemnly resolved to constitute India into a [1]**[SOVEREIGN SOCIALIST SECULAR DEMOCRATIC REPUBLIC]** and to secure to all its citizens :

JUSTICE, social, economic and political;

LIBERTY of thought, expression, belief, faith and worship;

EQUALITY of status and of opportunity; and to promote among them all

FRATERNITY assuring the dignity of the individual and the [2][unity and integrity of the Nation];

IN OUR CONSTITUENT ASSEMBLY this twenty-sixth day of November, 1949 do **HEREBY ADOPT, ENACT AND GIVE TO OURSELVES THIS CONSTITUTION.**

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1. Subs. by the Constitution (Forty-second Amendment) Act, 1976, Sec.2, for "Sovereign Democratic Republic" (w.e.f. 3.1.1977)
2. Subs. by the Constitution (Forty-second Amendment) Act, 1976, Sec.2, for "Unity of the Nation" (w.e.f. 3.1.1977)

Language and Literature of India

1

Language is one of the most beautiful and intriguing phenomenon in the world. It is closest to all living beings, carving the rhythm of their life.

It is language that fulfills our wish to be understood by others in life time and remembered ever after. The most creative minds have always adored language as their muse.

Interestingly there are many languages without a script but they fulfill the urge of expression of creative thoughts, ideas and mutual interactions. They connect the speaker with listener reliving the experiences, for example, we have beautiful, rich oral traditions of presenting time and space in the form of storytelling, *Kavaad Banchana*[1] (story telling). *Phad* singers[2], folktales, dialects, historical narrations, paintings, dance, etc. These were the most reliable and popular medium before the advent of writing systems and are accessible even today to people. All major forms of literature: *śruti, smṛti, purāṇa*, epics, poetry, folk tales, and myths are preserved and are still alive in oral traditions of the country.

The art forms of dance and painting are expressions in language without the writing tools.

1. *Kavaad Banchana*: is a traditional form of oral storytelling, *Kavaad* means panel of a door and *Banchana* means to narrate and show the illustrated story on the panel.
2. *Phad* singers: *Phad* is a scroll that depicts the narratives of folk deity. The *Bhopas* of Rajasthan are the *phad* singers who are invited to villages to sing to appease the deity.

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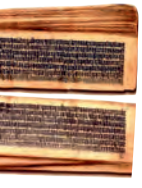

Language and Human Life

The question why do we need language has inspired linguists and people in general to unravel the mysteries which surround it. In Sanskrit the word for 'Language' is Bhāṣā, which is derived from the root *Bhāṣ*, which literally means 'to speak', 'to say'. Perhaps this testifies that language originated from the need of expression and communication, hence it manifests in our thoughts and actions. This draws our attention to the fact that language is an integral part of social and cultural lives of human beings. It is the primary means by which culture is expressed, and maintained too. The overwhelming amount of knowledge created and owned by human beings is passed on from generation to generation in language.

Language mediates our relationships and it is instrumental in the process of evolution of human civilisation. If we turn the leaves of history, language had always played a significant role in making as well as destruction of kingdoms, rulers and eras. Kings, rulers and other dominant people/classes have always been identified with a language spoken and used solely by them. There have been attempts to curb the use of certain languages. The fury of territorial invasions among the invaded in the past subsided when the invaders had adapted to the culture as well as language of the territory, for example the birth of Urdu and Hindustani in India is a result of intermingling of Mughals with the natives.

Multilingualism is the Core of our Knowledge System

Among the interesting discoveries were—200 words describing snow in the Himalayan region alone, an old form of Portuguese spoken in villages close to Mumbai, a form of Japanese spoken in parts of Gujarat, and a language from Myanmar that is popular in the islands of Andaman.
— Ganesh N. Devy, *People's Linguistic Survey of India*

The creation of human experiences, thoughts, feelings and history is not about layering one experience on another according to time and dates, it is a narrative in language of understanding and reflection. Perhaps that is why it is said that language gives distinctive meaning to experiences.

Language Promotes Co-existence

Ethics are shared rules of living in a culture. Source of conflict in societies lies in misunderstanding and lack of awareness about each other's cultural practices and ethical norms. People can live in harmony with each other only if they know,

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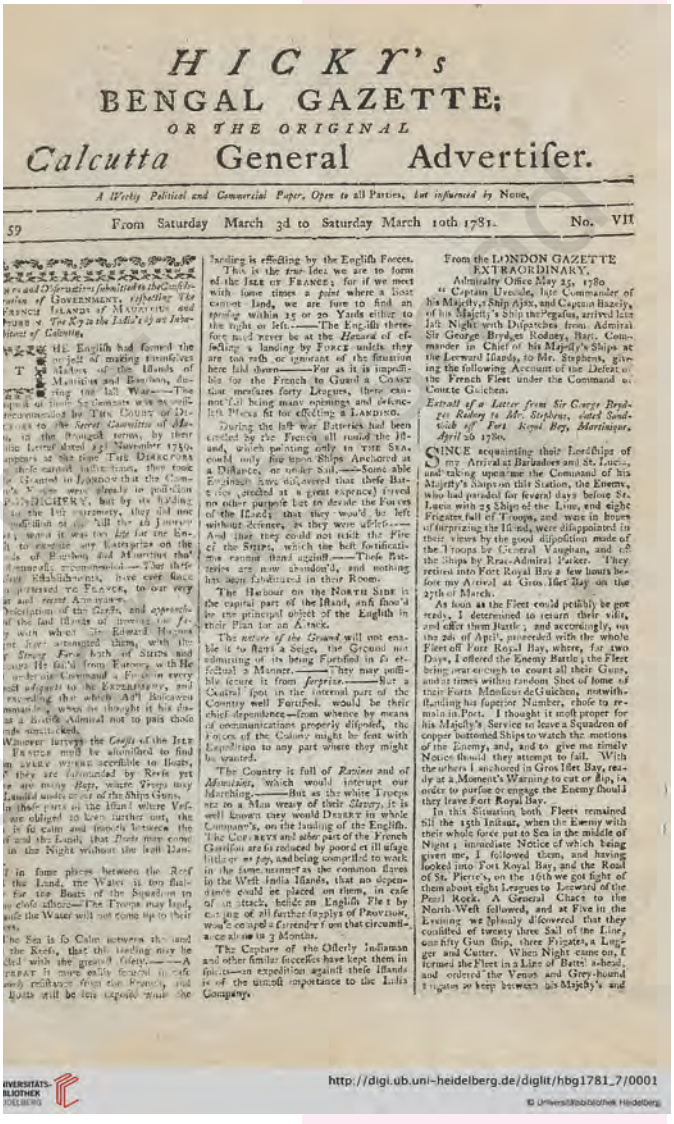
understand and respect the ethical and moral norms of society to which they belong. Exposure to other cultures adds to our awareness about human life and issues of existence. Opinions and concerns about socio-ethical issues, social justice and human rights issues of a community are also voiced through their shared language. It is in the process of learning language that these values embedded in culture are absorbed. Language becomes an intrinsic aspect of our human inheritance.

Journey of ideas from printing press to people, India's first newspaper *Udant Martand* was published form Kolkata in 1826. This was a weekly newspaper published by Pt. Jugal Kishore Shukla.

Literature in different languages sustained the spirit of struggle for freedom from British rule. It became the social responsibility of the writers to write with a purpose of awakening people to ideas of justice, and freedom from slavery. Bankimchandra Chattopadhyaya (1838–94) brought out a magazine *Bangadarshan* to educate people on social and political issues of the time. *Kavivachansudha* by Bharatendu Harish Chandra (1850–85) became the voice against the atrocities of prevailing authority. Bharatendu's songs for *Prabhat Pheris* and songs were sung with fervour. Another important development was *Bengal Gazette*, the first newspaper in India and Asia as well. It was founded by James Augustus Hicky, who visualised the newspaper as a forum for people to voice their opinion. He was sarcastic and critical of the events and policies of the British rulers. It was said that *Bengal Gazette* made people's lives easier; instead of writing long letters to their friends and relatives, they sent copies of the newspaper.



HICKY's
BENGAL GAZETTE;
OR THE ORIGINAL
Calcutta General Advertiser.

A Weekly Political and Commercial Paper, Open to all Parties, but influenced by None.

59 From Saturday March 3d to Saturday March 10th 1781. No. VII

http://digi.ub.uni-heidelberg.de/diglit/hbg1781_7/0001

Front page of Hicky's Bengal Gazette, 10 March 1781, from the University of Heidelberg's archives

- Identifying oneself with one's own language is possible in the presence of other languages. Debate with peers.
- Trace the role of journalism in the lives of people today.

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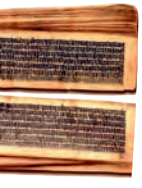

Language and its Science

We do not remember how we started using the language but certainly it was much before we were taught either at home or school. However, scientific study of language is another insightful dimension about language. The study of science of language began when the minds of people were troubled by the universality and diversity in language. Interestingly the diversity in language was explained as a punishment for man. The earliest masters in linguistics were ancient Indian grammarians. The works of Panini and other Sanskrit grammarians had profoundly influenced the linguistic science. The interpretations of ancient poetry also aroused interest in the study of language. The nineteenth century saw an enormous development in the science of language; the horizon was widened and many languages as well as the use of language in poetry and drama was also studied with keen interest.

This led to some significant shifts in language study. Diversity in language was accepted. It was recognised that the greater the range of registers a speaker has at his disposal, the more effective will be social interactions with the world at large.

Another important development was the realisation that languages are not static, they are always in state of flux. Languages keep on changing as long as they are spoken. It is users of the language who nurture languages to keep them alive, hence, language has no independent existence apart from its users.

> Languages become endangered if they lose the number of speakers drastically. The dying languages become the cause of the death of a culture... a perspective to look at the world is lost. Languages thrive because of their speakers.

> The science of language is based on a system. Find examples from the language of your choice like usage of language and grammar.

India's Language Diversity

Languages represent multitude of people and their lived experiences. Our country is very rich in linguistic diversity. This diversity is an outcome of many factors that shape life on the subcontinent. Its territorial space is marked by mountains, river basins, coastlines, dense forests and deserts. This wide topographical range harbours a variety of

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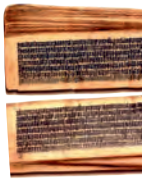
environmental conditions which influence the language and culture of people living in these regions. Thus, India houses maximum number of written and orally alive languages in the world. The diversity of languages, cultures and traditions makes India one of the most tolerant and harmonious country.

India is home to five major language families. These language families are: Indo-Aryan, Dravidian, Austro-Asiatic, Tibeto-Burmese and Semito-Hamitic. India's rich linguistic and cultural heritage is mirrored in her literatures, both oral and written.

Sanskrit belongs to Indo-European group of languages. Sanskrit was gradually standardised and given a highly scientific grammar by Panini, the great grammarian, in about fifth century B.C. Sanskrit was the language of religion, philosophy and learning. The people spoke a number of dialects which are called *Prakrits*. Buddha preached in the language of the people. Buddhist literature was written in *Pali*, one of the *Prakrits*. Among the Dravidian languages, Tamil is the most ancient. The others developed during the first millennium of the Christian era. Though Sanskrit again became the predominant language of learning in the period of the Guptas, the *Prakrits* continued to develop. The various spoken languages that developed are called *Apabhramshas*. These formed the basis of the modern Indian languages which developed in various regions of India during the medieval period.

Literature and Cultural Expression

Literature presents the panorama of the history of mankind; the social institutions, religious beliefs, scientific achievements and philosophical ideas. The objective is to present the journey of thoughts from the earliest times to the present times. The literature in a variety of forms appeals to the readers because it relates to the questions of human life. There is a unique linguistic variety in literature but it keeps pace with the cultural evolutions in the society and the common thread runs across the literatures creating a continuum of the progress of human civilisation. It was the advent of British era that marked the change in the course of language and literature. The tradition of nurturing plurality of languages strengthened in the modern era, enriching almost all the regional languages with a rich oral and written body of literature. The establishment of printing press by 1800 brought remarkable changes in the field of communication. The author could communicate directly with the reader in the languages of the people. The rise of journalism with the introduction of newspapers and magazines helped the development of prose writing which was so far a neglected



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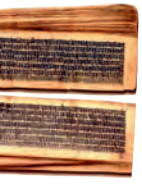

field. Earlier the British felt that for expansion of their power learning local Indian languages would be of great benefit but by 1835, Macaulay's Minute on Education changed their thinking and English began making its presence felt in the political and social life of the people of India by the end of 19th century English. The contact with West opened new avenues in the realm of socio-political thought, themes and forms such as free verse. In the recent years, more Publications in English by Indian writers are being seen on bookshelves. Many Indians started writing in English as well. Henry Derozio and Michael Madhusudan Dutt are the pioneers in this field.

There is however, no complete departure from the tradition, in that many modern writers, including those who wrote in English, continue to draw their inspiration and themes from the classical epics and other texts. Several Indian writers have written par excellence not only in traditional Indian languages but also in English. India's Nobel laureate in literature was the Bengali writer Rabindranath Tagore, who wrote some of his work originally in English, and did some of his own English translations from Bengali. Writers like Vikram Seth, Raja Rao, Anita Desai, Shashi Deshpande, R.K. Narayan, Ruskin Bond, derived inspiration from Indian themes.

Here is the translation of a Tamil poem in English. Translation, as a creative genre, is the characteristic of modern literature.

Poetry: Kuruntokai Poem 312
Poet: Kapilar

What He Said

My love is a two-faced thief.
In the dead of night
she comes like the fragrance
of the Red-Speared Chieftain's
forest hills,
to be one with me.

And then, she sheds the petals
of night's several flowers,
and does her hair again
with new perfumes and oils,
to be one with her family at dawn
with a stranger's different face.

Translated by A.K. Ramanujan

Share your experiences with peers about reading literature. You can explore on the basis of the following:

- Reading literature gives pleasure when it connects with our lives and surroundings
- Reading about something unfamiliar is exciting and thought provoking
- The focus in reading is on the thought and ideas, not how the sentences are constructed
- Discuss at least two works of an author of your choice

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We may tabulate the history of Indian literature as:

- *Vedic* Literature, approx. up to 1200 B.C.E.;
- Classical Literature, from 1200 B.C.E. to fifth C.E. (in classical Sanskrit, *Pālī*, *Prākṛt* and Tamil);
- *Prākṛt* Literature, from 1st century C.E. to eleventh century (in various *Prakrits*);
- *Apabhraṁsa* Literature, from seventh century CE to eighteenth century (regional Indian languages' literatures);
- Indian-language literatures in modern period, from eighteenth century

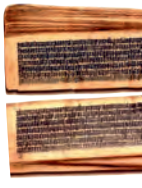
A Mosaic of Language and Literature in India

The history of Indian literature is ancient and vast. It had been an instrument of instruction since antiquity. *Śruti* and *Smṛti* literature, *Sūtra literature, Jātaka tales*, *Pancatantra, Kathasaritsāgara*, *Thirukural, Athichudi and Vachanas* are examples of traditions of literature which have enriched human life encouraging them to follow human values, and living in harmony with nature. In India, in the sixth and seventh century, A.D., there were great literary skills in epic poetry and drama. Indian intellectuals explored the field of medicine, astronomy, geometry, law and many others. The Indian thinkers explored religion and philosophy with vigour and originality in the interest of the people.

Ancient period falls roughly between 2000 B.C. to A.D. 1000. Sanskrit, Tamil, Pali and Prakrit were the main languages used for writing in ancient times. Other languages of antiquity include Kannada, Ardhamagadhi and Apabhramsa. Sanskrit literature from ancient period can be divided into the following.

Vedic Age

From this pristine antiquity, we receive two types of literatures namely 'Śruti' (heard and revealed) literature and 'Smṛti' (remembered and later recorded) literature. The four *Vedas—Ṛgveda, Yajurveda, Atharvaveda* and *Sāmveda* along with eleven *Brāhmaṇas*, three *Araṇyakas* and more than 100 *Upaniṣads* belong to the *Shruti* form. *Smṛti* texts are ascribed to human authorship and contain six *Vedāṅgas* (adjuncts to the *Vedas*), the epics—the *Rāmāyaṇa*, the *Mahābhārata* and the *Purāṇas*. The *Vedas* describe procedures for *yajñas*, sacrifice and prescribe rituals and mantras to invoke powers of various gods to attain success in human efforts. All human effort in *vedic* way of life is put into four *puruṣārthas* ('purpose of life on earth')—*Dharma*, *Artha*, *Kāma* and *Mokṣa*. *Upaniṣads* are contemplative enquiries into the mysteries of



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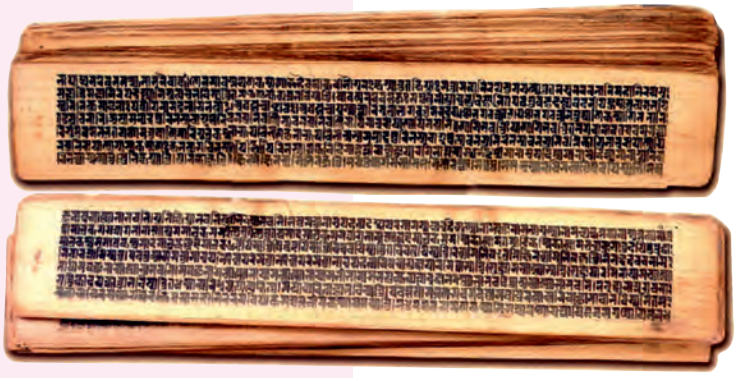

Ṛgveda (padapāṭha) manuscript in Devanagari, early 19th century

Source: *Vedparijat*, (August, 2014), NCERT

life. The two epics are narratives on the legendary life of Rāma and Kṛṣṇa—the famous avatāras of Lord Viṣṇu.

Post Vedic age

In the post Vedic period, Sanskrit literature evolved in the form of drama, verse and prose. Significant playwrights of the period were Bhāsa, Kālidāsa, Śūdraka and Bhavabhuti. Bhāsa's plays largely adopted their subject from the epics of the *Rāmāyaṇa* and the *Mahābhārata*. Thirteen of his plays are extant and some of them are: *Svapanavāsavadattam, Cārudattam, Abhiṣekanāṭakam, Pratimānāṭakam, Karṇabhāram* and *Madhyamavyāyogam*. Kālidasa is considered as the greatest Sanskrit poet and playwright. His poem *Meghadūtam* and his play, *Abhijñānaśākuntalam* are world renowned. Here are some classic expressions from ancient Sanskrit literatures.

From the *Ṛgveda*

Devī Sūktam

सङ्गच्छध्वं संवदध्वं सं वो मनांसि जानताम्।
देवा भागं यथा पूर्वे सञ्जानाना उपासते॥

Saṅgacchadhvaṁ saṁvadadhvaṁ saṁ vo manāṁsi jānatām
devā bhāgaṁ yathā pūrve sañjānānā upāsate

May you move in harmony, speak in one voice, let your minds be in agreement just as the ancient gods shared their portions of sacrifice.

From Taittirīya Upaniṣad

वेदम् अनूच्य आचार्य: अन्तेवासिनम् अनुशास्ति
सत्यं वद, धर्मं चर, स्वाध्यायात् मा प्रमद:,आचार्याय
प्रियं धनम् आहृत्य प्रजातन्तुं मा व्यवच्छेत्सी:, सत्यात् न
प्रमदितव्यं, धर्मात् न प्रमिदतव्यम्, कुशलात् न प्रमदितव्यम्
भूत्यै न प्रमिदतव्यम्, स्वाध्यायात् न प्रमदितव्यम्।

vedam anūcya ācāryaḥ antevāsinam anuśāsti—satyam vada, dharmaṁ cara, svādhyāyāt mā pramadaḥ, ācāryāya priyaṁ dhanaṁ āhṛtya prajātantuṁ mā vyavacchetsiḥ, satyāt na pramaditavyaṁ, dharmāt na pramaditavyaṁ, kuśalāt na pramaditavayaṁ, bhūtyai na pramaditavyaṁ, svādhyāyat na prmaditavyam.

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This is the advice of teacher to his pupils at the end of their stay in Gurukul. The Guru urges them to follow the path of truthfulness and work for the welfare of others.

From Raghuvaṁśam by Kalidas

शैशवेऽभ्यस्तवद्यानां यौवने विषयैषिणाम्।
वार्धके मुनिवृत्तीनां योगेनान्ते तनुत्यजाम्।।

śaiśavebhyastavidyānāṁ yauvane viṣayaiṣiṇāṁ
vārdhake munivṛttīnāṁ yogenānte tanutyajām

- What are the features of Vedic and Post Vedic literature?
- What were the languages of literary writings during Vedic and Post Vedic Literature?
- Recite Devī Sūktaṁ with intonation.

Prākṛt, Pālī and *Apabhraṁsa*

'Prākṛt' ('natural' or 'common') was an important colloquial language which was used in Sanskrit drama for dialogues of women and minor characters. *Gāthā Sattasai* is a third century work in Prākṛt. Ashoka's inscriptions have also used Prākṛt along with Pali. Buddhist philosophical work like *Dhammapada* and educational stories like Jātaka Tales are in Pali. Lord Mahavira Jain used *Apabhraṁsa* to disseminate his teachings.

Ancient Tamil Literature

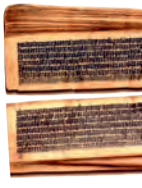
Ancient Tamil literature is known as Saṅgama Literature. The earliest known work in the ancient Tamil is *Agastyam*. Another seminal work Tholkapiayam (300 B.C.) is a treatise on Tamil grammar. 'Akam' ('interior landscape') and 'Puram' ('exterior landscape') forms of poetry also come from Sangam period. It conceptualised five landscapes, known as 'tinai' which denotes a literary category named after a flower native to that natural setting. The tinais are:

- *Kurinchi* (mountain and mountain related landscape),
- *Mullai* (forest and forest related landscapes),
- *Marutam* (cultivable field and field related landscapes), *Neytal* (sea and Sea related landscapes), *Palai* (dry, a kind of arid desert and desert related landscapes).

The two epics found in Tamil are *Cilapathikaram* and *Manimekalai*.

Regarded as one of the great works of Tamil literature, the *Silappadikaram* is a poetic rendition with details of Tamil culture; its varied religions; its town plans and city types; the mingling of different people; and the arts of dance and music.

Manimekalai is composed by the poet Chithalai Chathanar. *Manimekalai* is a poem in 30 cantos. It is a story of Kovalan and Mādhavī who became Buddhist Bhikkhuṇi.



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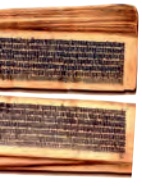

Ancient Kannada literature

Earliest work extant in Kannada literature is *Kavirājamārgam* from ninth century. Kannada language is known to exist since the third century B.C. Pampa, Sri Ponna and Ranna are three major Jaina poets who wrote in classical Kannada in the tenth century A.D. Ādikavi Pampa's *Rāmāyaṇa* in Kananda is the most significant source text for the poets of the succeeding generations.

- Describe the features of ancient Tamil literature.
- Name the three poets who influenced the Kannaḍa poetry.

The Epics

The two epics of India *Mahābhārata* and *Rāmāyaṇa* are the representations of cultural, religious and political lives of the people of Indian subcontinent. The epics are written in the literary tradition of *Kāvya*. The epics are the reflection of heroic age embedded with value and moral teachings for human beings. These epics have been an enduring part of visual and oral traditions of transmitting knowledge in India hence have a profound influence on the lives of people. The epics have been translated into many languages and dialects across the world.

Kannagi from the Tamil Epic Silapathikaram

The *Rāmāyaṇa* is considered as the foremost literature in classical Sanskrit and its author Vālmīki is known as the 'Ādikavi'. The *Rāmāyaṇa* is a saga of life of Lord Rama which is composed in 24000 verses. The epic is the source of inspiration for many poets in ancient, medieval and even the modern times. The *Mahābhārata* is written by *Vedavyāsa* who enriched our literature with significant literary and *shastric* treatises like the *Purāṇas* and *Brahmasūtras*, and perhaps the first to write *Vedas*. The *Mahābhārata* consists of one lakh verses which are supposed to be the largest work of literature in any time and in any language. Indian tradition treasures a legend saying that any knowledge related to humankind has a place in the *Mahābhārata*. The world famous *Bhagavad-Gīta*, consisting of 700 verses forms a part of the *Mahābhārata* in the 6th *Parva* (chapter) out of its 18 *parvas*. *Bhagavad-Gīta* is a complete philosophical doctrine which answers our personal emotional dilemmas. It shows threefold paths to seeking and attainment of salvation (*mokṣa*) which are the paths of *Karma*, *Jñāna* and *Bhakti*.

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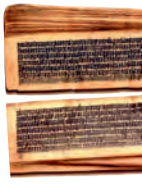
The Rāmāyaṇa became the symbol of life of prosperity, *dharma*, harmony and spiritualty—*rāmarajya* for the people representing Indian philosophy and culture. There are many versions of the *Rāmāyaṇa* which differ in language but the core philosophy remains the same, touching the heart and soul of people. The *Rāmāyaṇa* also served as a source for themes for later writers. The great writer Kalidasa drew inspiration for his literary works like *Kumārasambhavam* and *Meghdūtam* from the *Rāmāyaṇa*.

Classical Languages of India

A language is accepted as a classical language, if it has an independent tradition, antiquity and rich repertoire of classical literature. A classical language should be ancient and it should have its own independent tradition, not influenced by any other tradition. It must have a large and extremely rich body of ancient literature. The Sahitya Academy of India prescribed the following four criteria for a classical language in the year 2004.

- The high antiquity of early textual history of over 1500 to 2000 years.
- A body of ancient literature that is considered a valuable heritage by generations of speakers.
- The literary tradition should be original and not borrowed from another speech community.
- The classical language and literature should be distinct from the modern and there may also be a discontinuity between the classical language and its later forms of offshoots.

Government of India accorded classical status to some languages in India based on their antiquity and their traditions. Languages have been given the status of classical language. Given in bracket are the years in which the language was given the status—Tamil (2004), Sanskrit (2005), Telugu (2008), Kannada (2008), Malayalam (2013) and Odiya (2014).



The Rāmāyaṇa

As the story goes, the aged king Daśaratha chooses one of his four sons, Rāma, to succeed him as the ruler of Ayodhyā, but is finally persuaded by one of his wives to name Rāma's brother Bharata as his successor. Bowing to his father's decision, Rāma prepares to leave the capital and his wife. Sītā refuses to accept this separation and insists on accompanying Rāma and his brother Lakṣmaṇa into exile.

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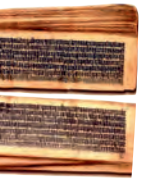

The city was distressed and citizens were dazed
And crowds unending followed as he went.
Rāma arrived where Jānaki was.
Startled, she rose, for she did not understand
Why the crowd did weep or why they came
Thus dazed and covered with dust.
Nor why her prince was strangely clad.
Her fright increased
As the women about embraced her;
They would not speak but smothered her in tears.
She turned her large eyes then to Rāma:
"My prince, tell me now,
Is the king well
Or has some illness stricken him?"
And Rāma quietly spoke:
"My peerless brother beloved will rule the realm
By the command of them that gave me being.
I go today to see the hills
From where the rains are sent.
And till I come again abstain from grief."
She sobbed but not for his dread exile
Or for the kingdom's sake:
She sobbed for the cruel words that scalded her ears:
"Grieve not the time I shall be away!"
For how could Sita bear the thought
Of separation? Were they not
An eternal pair together in the sea of milk
Together again on earth when he chose to be born…

Ayodhyā Canto of the *Rāmāyaṇa* by Kamban, one of the greatest classic Tamil poets of the ninth century. Translated from Tamil by Sri Chakravarti Rajagopalachari.

Fables in Ancient Literature

Pañcatantra

The *Pañcatantra* is a collection of ancient India fables. It is believed that Vishnu Sharma composed them in first century C.E. It has influenced the composition of literature in other parts of the world, for example the writing of Aesop Fables. *Pañcatantra* fables are marked by a moral. The idea that an action has consequences is well portrayed in these fables. The fables are widely popular even today because of their simplicity, logic and human desire to follow morals and values in life.

Here is a sample of its style

A donkey was employed in pulling a washerman's cart and after the day's labour, at nightfall, he liked to have a good feed off the neighbour's cucumber field. A jackal once joined him,

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and when the two had feasted on the cool and delicious fruit, the donkey exclaimed: "Isn't it a glorious night, old fellow? I feel so jolly, I must sing a song." The wise jackal thought that they should leave the field stealthily keeping quiet, but the silly ass brayed merrily, until the farmer then woke up and gave him a sound thrashing.

Jātaka Tales

Jātaka Tales

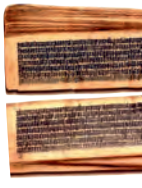
Source: https://search.creativecommons.org/photos/fdf30c26-6fee-467b-8fc5-fce66cf89229

Jātaka stories emphasise Buddha's great abilities as a visionary and storyteller. The stories are marked by moral lessons. The stories are important to know the culture of the people, and also inspire literature, theatre opera and other art forms. Jātakas are the birth stories of Buddha. Jātaka tales are said to be one of the most authentic account of life in ancient India. The stories capture the various incarnations of Buddha, practical wisdom, lives of people in frames of hope, happiness and despair. The stories present life in bazaar, caravan, field barracks and life lived in quiet and thought mediations.

Here is a sample of its style

Prince Suvaṇṇa Sāma (the devoted prince) — Act of benevolence

Sāma's parents lost their sight when he was 16 years old. From then on he was their only help. He took care of his parents. Every day he went to the Migasammata River to gather fruit and fetch water in a pot. At that time King Piliyakkha of Benares in his great desire for venison, also



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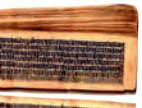

came to the river and at last reached the spot where Sāma stood. Seeing Sāma taming the wild animals, the King was wondering whether the creature was a god or a Nāga? To find out, he decided to wound and disable him, and then ask. The King shot a poisoned arrow and wounded Sāma, who fell to the ground. Sāma spoke: "I have no enmity against anyone. Who has wounded me?" The King went to Sāma and asked him his name. Sāma then told the King the story of fostering his blind parents. The King thought to himself, "I have done evil to such a holy being; how can I comfort him?" He decided to bring the blind parents to their son. In the meantime the goddess Bahusodarī decided to help Sāma and his parents. In the end Sāma recovered from his wound and both of his parents' sight was restored.

Hitopadeśa

Hitopadeśa is a book of worldly wisdom presented through the characters of birds, animals and humans. The purpose of the book appears to encourage proficiency in Sanskrit expression and the knowledge of wise behaviour (*nīti-vidya*). The stories are elaborate, ending with moral messages. However, very peculiar to its style, it has condensed and crisp verses in between the stories to illustrate the points made by the characters.

Hitopadeśa is structured in four books with a preface (*prāstāvika*). The four books are as follows:

- *Mitralābha*
- *Suhṛdbheda*
- *Vigraha*
- *Sandhi*

Here is a sample of a story from the book *Suhṛdbheda*

The Story of the Black Snake and the Golden Chain

"A pair of crows had their abode in a certain tree, the hollow of which was occupied by a black snake, who had often devoured their young. The hen-bird, finding herself breeding again, thus addressed her mate: 'Husband, we must leave this tree; we shall never rear young ones while this black snake lives here! You know they say—

'From false friends that breed thee strife,
From a house with serpents rife,
Saucy slaves and brawling wife—
Get thee out, to save thy life.'

'My dear,' replied the crow, 'you need not fear; I have put up with him till I am tired. Now I will put an end to him.'

'How can you fight with a great black snake like that?' said the hen-bird.

'The Lion proud died by the hare so meek.'

'How came that about?' asked the hen-crow.

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Doubt nothing,' answered the other— 'He that hath sense hath strength; the fool is weak…'

The Book of Good Counsels: From the Sanskrit of the Hitopadesa, by Sir Edwin Arnold, M.A. 1861

- Read and describe Ayodhyā Canto of the *Rāmāyaṇa* by Kamban in your words.
- What is the common thread in the fables of *pañcatantra*, *jātaka* and *Hitopadeśa?*

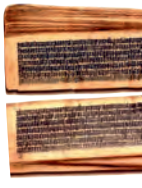
Medieval Period

Emergence of the *Bhakti* Movement

In the A.D. sixth century, *Bhakti* emerged in the Tamil land and there was an upsurge of *bhakti* poetry. Compositions of *Alvars* (the word literally means immersed in God) and *Nayanmars* are expressions of *Vishnu* and *Shiva bhakti*. In Kannada region *Basavanna* (1105–68) in the twelfth century began the movement in response to the prevailing caste hierarchy. The bhakti literature is known as *Vacanasāhitya*. *Akkamahadevī*, *Allama Prabhuare* the proponents of *Bhakti* movement. Jñānadeva, Nāmadeva and Tukārām contributed profusely to this movement connecting to people in their language in Marathi.

In northern India Kabir emerged as a great force in lending support to Bhakti movement. His verses were like a mirror to the hierarchy ridden society of that time. He spoke with all humility and faith in God. Another believer in *Bhakti* was Guru Nanak who tried to synthesise the different religious faiths to serve as a guide for humanity. He preached devotion to God than rituals.

Poet-saints who produced literary masterpieces include Chaitanyadeva in Bengali, Surdas in Hindi, Mira Bai in Rajasthani, Jnaneshwar in Marathi and Narsinha Mehta in Gujarati. The contribution of women writers needs special mention. The Kashmiri compositions of Lal Ded and Habba Khatoon are known for their mystical flavour and intense agony of expression, Mirabai's compositions in Rajasthani is known for a unique devotional quality, Andal's mysticism in Tamil and Akka Mahadevi's vachanas in Kannnada are testimonies to the great contribution of women to literature of the time. Besides this, medieval times were characterised by religious and cultural synthesis that integrated the Islamic and Sufi elements into the culture and literature of Northern and Western India.



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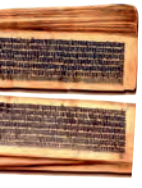

Renderings of Bhakti Poets

Guru Nanak

Guru Nanak was a spiritual Guru whose teachings were expressed in devotional hymns. He was a *Nirguna Bhakti* saint and a social reformer. He was an opponent of caste and religious distinctions. Guru Nanak firmly believed and preached that the most important form of worship is *bhakti*—loving devotion to God. He was the first Sikh Guru and the founder of Sikhism.

Gaganmahthāl, rav-cāṅddīpakbaney
tārkamaṅdaljanakmotī
dhūpmaliāṅlopavancāvarokarey
sagalbanraiphūlantjyoti.

Translation—The Sky is your platter,
The sun and moon are the dīpakas [lamps or lights],
The stars in the sky are the pearls,
The dhūp [incense] is the fragrance
That the wind propels,
The whole forest is your flowers.

Kabir

Kabir was a mystic poet and saint. He represented *Nirgun* stream of Bhakti movement. Kabir is revered for his verses which expressed his philosophy with simplicity and honesty. There is no evidence that he received any formal education. Kabir wrote from his experiences which he gained through his travels and *satsangs*. He opposed distinctions of caste and creed and propagated harmony among people.

Aisī vānī boliye, mana ka āpā khoye
Apnā tan śītal kare, auran ko sukh hoye.

Translation—Speak such words, sans ego's ploy
Body remains composed, giving the listener joy.

Lal Ded

Lalleshwari, locally known mostly as Lal Ded, was a Kashmiri mystic of the Kashmir Shaivism school of Philosophy in the Indian subcontinent. She was the creator of the style of mystic poetry called vatsun or Vakhs, literally 'speech'.

Another feature of this period is the emergence of Urdu as a language of confluence of Persian and Hindustani that marked the beginning of poetry forms like *qasida, marsiya* and *masnavi,* which found ready acceptance in Urdu and Kashmiri. It is interesting to note that when the Christian Missionaries came to India and wanted to compose on biblical themes, some of them adopted indigenous forms like *puran* and *pana.*

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You are the heaven and you are the earth,
You are the day and you are the night,
You are all pervading air,
You are the sacred offering of rice and flowers and of water;
You are yourself all in all,
What can I offer you?

—Translated by R.C. Temple

Mirza Ghalib

Mirza Ghalib was a prominent Urdu and Persian poet during the last years of the Mughal Empire. His honorific was Dabir-ul-Mulk and Najm-ud-Daula. Most notably, he wrote several ghazals during his life, which have since been interpreted and sung in many different ways by great artists. Today Ghalib remains popular not only in India and Pakistan but also among the Hindustani diaspora around the world.

apnī hastī hī se ho jo kuchh ho
āgahī gar nahīñ ġhaflat hī sahī

- What are the causes of emergence of Bhakti movement?
- Collect and read *dohas, vakhs* and other writings of Bhakti movement. Find the characteristics of style of writing.

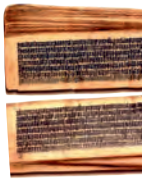
Let us Do

1. There are many categories of languages—classical languages, modern Indian languages, tribal and minor languages. Why are they called so? Find what this categorisation mean.
2. What makes a language a classical language? Define it.
3. Select poem from one language and translate it into as many languages as possible with your friend.

Project Work

1. In groups of four select five poets from five different Indian languages and collect information about their work, time, life and philosophy to carry out the project.
2. The *Rāmāyaṇa* and the *Mahābhārata* have been written in almost all Indian languages. Pick any three or four languages and collect information on the origin and writing of the two epics. Compare and contrast the commonalities and difference in different languages.

As said earlier, *Hitopadeśa* was written to exemplify a pious life through stories with moral teachings.



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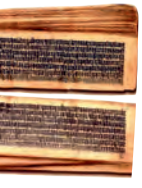

The following are two proverbs from Hitopadeśa. Read and collect more proverbs to understand the idea of the book.

- Sentences of studied wisdom naught avail if unapplied; though the blind man holds a lantern, yet his footsteps stray aside.
- Fellow be with kindly foeman rather than with friends unkind; friends and foeman are distinguished not by title but by mind

—Translated by Sir Edwin Arnold

Organise an activity

Organise a school literary festival in your school and present poems and other literary works to other students and parents. Have talks and discussions on Indian Literatures and their richness. You may invite writers, and poets to the event.

Further Reading

1. *India — What Can It Teach Us?* A Course of Lectures Delivered Before the University of Cambridge by Friedrich Max Müller Available at http://gretil.sub.uni-goettingen.de/gretil_elib/Mue883__MuellerFM_IndiaWhat.pdf
2. The Epics, History, Tradition and Myth and Life and Work in Ancient India in *The Discovery of India* by Jawaharlal Nehru.

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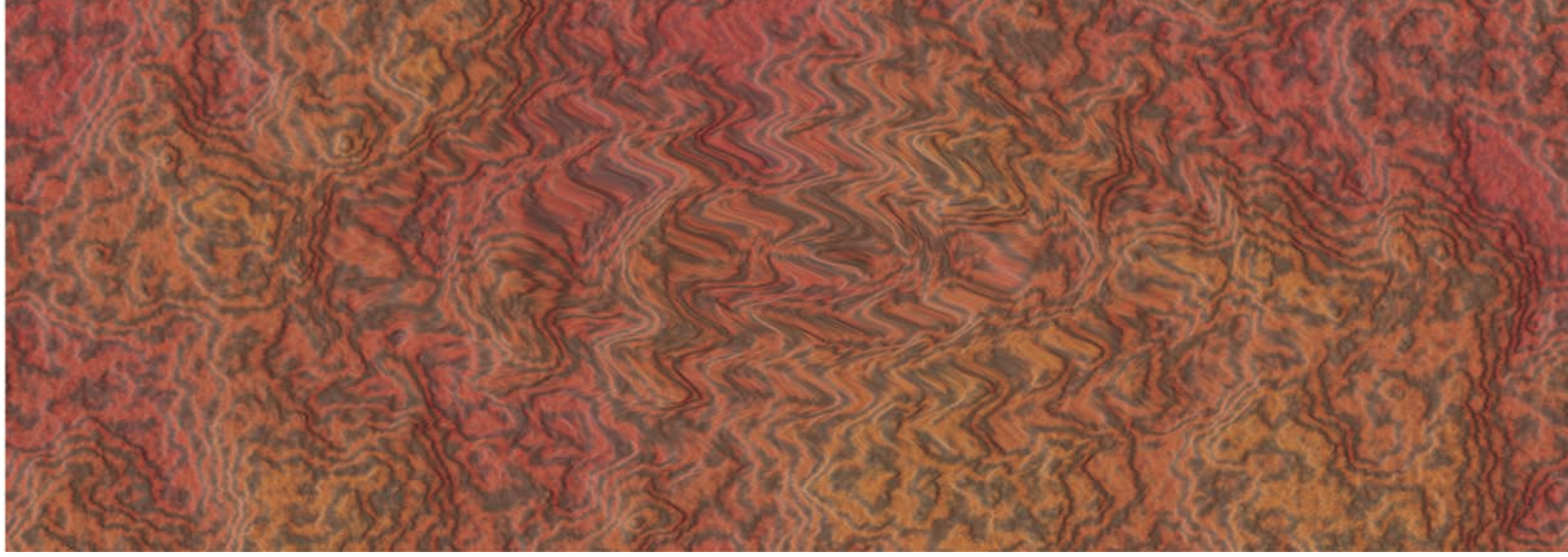

Indian Philosophical Systems

2

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We see the earth, the moon, the sun, and millions and billions of stars in the sky. We have big mountains, long rivers and unending oceans on our planet. We witness various climates like hot summer, heavy rain, and chilling winter. We observe human beings born, grow and die. Have you ever wondered about who has created these and who controls them? Certainly not us.

Human beings have been trying to find the answer since time immemorial. We can also have questions like what are the sources or means of our knowledge and how can we validate our knowledge.

Basically, these questions and answer to these questions are the subject matter of the study which is called *Darśana* or Philosophy in English.

Prameya (objects of knowledge) and *Pramāṇa* (means of knowledge or the source of knowledge), are the two major components of Philosophy in general. Different philosophical systems while defining their *prameyas* also define the *pramāṇas*.

The term philosophy is derived from the Greek term 'Philosophia'. The same remains in Latin and in old French, it is 'philosophie' meaning 'love of wisdom'. Deep knowledge of any subject which forms a theory or guiding principle is philosophy. In India, this knowledge system is called as *darśana*. The term is a Sanskrit word derived from the verbal root √dṛś, meaning 'to know' or 'to see' with the primary suffix *ana*, meaning the 'means'. Thus, the term *darśana* means the system which helps to know or to understand, whatever is there in the universe and beyond.

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A flawed means of knowledge will lead us to an unauthentic or invalid knowledge. In philosophical discourse, to determine the valid knowledge, we have two ways, i.e., direct and indirect. Here direct means the knowledge which can be perceived through the senses, i.e., *pratyakṣa*. And indirect means the knowledge which is not taken directly through senses like *anumāna, upamāna,* etc. The significant *pramāṇas* are as follows:

1. *Pratyakṣa* (Direct perception through sense organs)
2. *Anumāna* (Inference or syllogistic argument)
3. *Upamāna* (analogy)
4. *Śabda* (verbal testimony)
5. *Anupalabdhi* (non-perception)
6. *Arthāpatti* (implication)

Based upon these sources of knowledge, various Indian Philosophical schools discuss their subject matters which are metaphysical in nature like *ātmān (soul), Sṛṣṭi* (universe), *Īsvara* (god), *Mokṣa* (liberation), *Punarjanma* (rebirth), *manas* (mind), *buddhi* (intellect), so on and so forth.

Origin of Indian philosophical thoughts can be traced back to the first available literature of the world, i.e., *Ṛgveda*. Many hymns like *Nāsadīya sūkta, Puruṣa sūkta, Vāk sūkta, Jñāna sūkta,* etc., symbolically narrate about the creation of the universe, nature of self, etc. Philosophical discourse flourishes in the *Upaniṣads*, the last major part of the Vedic literature.

In the Post Vedic period, philosophical thoughts turned into independent schools, such as, *Sāṅkhya, Yoga, Nyāya, Vaiśeṣika, Mīmāṁsā, Vedānta, Cārvāka, Jaina* and *Bauddha*. Many schools carried forward the Vedic thoughts and elaborated upon them, whereas some schools developed their thoughts opposing the validity of the *Vedas*. Thus Indian philosophical thoughts are divided into two categories, viz., *Āstika* (that which accepts the validity of the *Vedas* as source of knowledge) and *Nāstika* (that which denies the validity of the *Vedas* as source of knowledge).

> In ordinary expression, these terms are used in different sense, like religious or irreligious and theist or atheist. But in technical sense of *darśana,* the words *āstika* and *nāstika* have no relation with religion and some *darśanas* have no concept of god and still considered *āstika* as their principles are adhered to the *Vedas*.

Cārvaka, Bauddha and *Jaina* are considered *Nāstika* schools as they don't take the *Vedas* as valid source of knowledge. Rest of the six schools come under the *āstika*

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category which have agreement in taking the *Vedas* as valid source of knowledge, though, they have differences among each other.

It is observed by our seers that the entire humanity is battered by the three-fold sufferings, viz., *ādhidaivika* (sufferings caused by nature), *ādhibhautika* (sufferings caused by creatures) and *ādhyātmika* (sufferings pertaining to mind and spirit). The ordinary means of eradicating human sufferings does help in it but it cannot cause complete (*aikāntika*), and everlasting (*ātyantika*) cessation of sufferings. Our seers always yearned for this kind of full and final freedom from sufferings where there is eternal bliss. This state is termed as *mokṣa* in Indian philosophy. The seers found that ignorance is the root cause of human sufferings and it can be dispelled only by the supreme knowledge.

In India, we find three main intellectual traditions, viz., *Nigama* tradition, *Āgama* tradition and *Śramaṇa* tradition. The tradition of *Nigama* (also known as Veda) believes that the Vedas are either eternal or the teachings of God. Hence, their authority is unchallengeable. This tradition is the base of the six prime systems of Indian philosophy. Apart from the *Nigama* tradition, there has been a parallel tradition of *Āgama*. In this tradition, the followers have their own scriptures either in Sanskrit or in other languages as well.

The followers consider there scriptures as divine revelation taught by God himself to different sages and spread through the chain of scholars. *Vaiśṇava Āgama, Śaiva Āgama* and *Śākta Tantra* are main representatives of the *Āgama* tradition. These too have several sub-sects.

The *Śramaṇas* were the monks who led a rigorous life. Around the sixth century B.C., different *Śramaṇic* groups appeared in opposition of the *Vedic* ritualistic culture and laid emphasis on leading a moral life. Their arguments were based on sound logic than mere faith and hence they appealed to the masses. Though many such groups are mentioned in the old literature of the Buddhism and Jainism, only a few of them sustained as philosophies for a long time.

Though there are many different philosophical thought systems developed in India, three *nāstika* and six *āstika* schools feature prominently in the history.

Nāstika Philosophical Systems

Cārvāka

It is the first and foremost *nāstika darśana*. Tradition names it as *lokāyata*, meaning, 'which appeals to the mass'. This philosophy is attributed to *Bṛhaspati* or his disciple as it has got another name as *Bārhaspatya darśana*.

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Cāṇakya in his *Arthaśāstra*, a treatise on public administration and finance, has called Bṛhaspati as the foremost teacher of *Arthaśhāstra*. This philosophy is believed to be as old as Vedic tradition.

It is an extreme *nastika darśana* which believes only one means of valid knowledge, i.e., direct perception or *pratyakṣa* and all other sources of knowledge are not trustworthy or misleading. Since only *pratyakṣa* is the valid means of knowledge, whatever is not there in its purview is not a true knowledge at all. So according to *Cārvāka*, not any supernatural power is god, but the king who possesses the power of punishing or rewarding over the people should be considered as god, since we get to know him through direct perception. Similarly, *mokṣa* (liberation) means death, bodily pleasure is *svarga* (heaven) and pain is *naraka* (hell). Forget about rebirths and which we don't perceive through our sense organs. Even this philosophy discards the fifth fundamental element of the universe, i.e., the *ākāśa* (the space) as it is not perceived to us. So, for him, only four fundamental elements are there, viz., earth, water, fire and air, which our sense organs can perceive.

For Centuries, *Cārvāka's* statement is quoted as

यावज्जीवेत् सुखं जीवेत् ऋणं कृत्वा घृतं पिबेत्।
भस्मीभूतस्य देहस्य पुनरागमनं कुतः।।

Yāvatjīvet sukhaṁ Jīvet ṛṇaṁ krtvā ghṛtam pibet|
bhasmibhūtasya dehasya punarāgamanaṁ kutaḥ||
As long as one lives, one should live happily. Even if you have to borrow, should consume ghee (for good health), (after all) how can a body come back after being burnt into ashes.

As *Cārvāka* is a fully materialistic philosophy, one question may be asked, i.e., if only body is the reality where does mind or consciousness come from which cannot be perceived by any of our sense organs, like eyes, ears, nose, tongue or skin. For this, *Carvāka* has answered with an analogy. According to *Cārvāka,* consciousness is not a different entity, but a byproduct of matter, just like we observe the living objects coming out of decomposing things.

Original text of *Cārvāka* is not available to us, which perhaps has been lost in the tradition. Whatever narratives are known to us, are found scattered in various literatures in Sanskrit. Views of *Cārvāka* had been compiled by a philosopher, viz., *Mādhava Vidyāraṇya* (A.D. 1296 to 1386). In that text, it is mentioned that for well-being of all creatures

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in the world, *Cārvāka* philosophy has to be adopted. It firmly criticises the practice of sacrifices in various rituals in the pretext of *dharma*.

The salient features of this philosophy are—

(i) World is made up of four elements: air (*vāyu*), fire (*agni*), water (*ap*), earth (*pṛthvī*). *Cārvāka* rejects ether (*ākāśa*).
(ii) There is no soul.
(iii) There is no God.
(iv) Rejection of two of the four *puruṣārthas* i.e., *dharma* and *mokṣa*.
(v) Enjoyment is the ultimate end.

From a bird's-eye view, though we can point out many flaws in this philosophy, particularly from the viewpoint of logical accuracy, this philosophy is adored across the mankind for its simplicity and practicality.

Jaina

The Jaina philosophy is primarily based on the teachings of twenty four *tīrthaṅkaras,* i.e., preachers. *Ṛṣabhadeva* is the first *tīrthaṅkara* as the tradition of Jainism maintains. Out of these twenty four *tīrthaṅkaras*, the last two, i.e., *Pārśvanātha* and *Mahāvīra* (sixth century B.C.) are historical personalities. The word Jaina is derived from a Sanskrit word *jina*, meaning the 'conqueror', i.e., conqueror of passion and desire. The last *tīrthaṅkara*, *Mahāvīra* is called *Jina* as he conquered his passion after the attainment of the supreme realisation.

The earlier Jaina literature is found in Prakrit. *Mahāvīra* himself used the same in his sermons. Sanskrit was introduced at a later stage for philosophical discourse. The first book of Jaina philosophy, i.e., *Tattvārthādhigamasūtra* was written by *Umāsvāmī* or *Umāsvāti* around second century A.D. The book deals with almost all philosophical doctrines of Jainism.

Mahavira Jaina

Source: *An Introduction to Indian Art*, Part–I (February, 2018), NCERT

The distinct features of Jaina philosophy are—

- Independent existence of consciousness and matter;
- No existence of supreme divine authority for creation, preservation or destruction of the universe;
- karma, the basic principle of one's creation and destruction;
- Relativity and multiple facets of truth;
- Morality and ethics for liberation.

The Jaina philosophy revolves around two main doctrines, i.e., *Anekāntavāda* and *Syādvāda*. Both are extremely connected doctrines. According to *anekāntavāda*, every being has numerous properties. The permanent property that constitutes the nature of a thing is called attribute (*guṇa*).

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The accidental property is called mode (*paryāya*). According to *syādvāda*, our knowledge is partial and relative because passion, anger, greed, etc., obstruct our knowledge. But, we deem our partial and relative knowledge as complete and absolute. Only a liberated soul can know the reality in totality.

Jaina philosophy admits that all souls (*jīvas*) are potentially equal because all of them are naturally endowed with four infinites (*anantacatuṣṭaya*), viz., infinite knowledge, infinite faith, infinite power and infinite bliss. But, in the stage of bondage, these four infinites are not manifested properly.

Jaina mentions the different stages that a soul (*jīva*) undergoes. These are as follows:

1. *Āsrava* (influx): Due to passion, anger, greed, etc., present in the soul (*jīva*); the karmic matter (*karmapudgala*) moves towards the soul (*jīva*).
2. *Bandha* (bondage): The karmic matter (*karmapudgala*) infests the soul (*jīva*) and obstructs the manifestation of the four infinites (*anantacatuṣṭaya*) just as dust particles settle on moistened leather reduces the shine of it.
3. *Samvara* (pause): A Jaina *sādhaka* stops the influx of the karmic matter (*karma pudgala*) through his virtuous conduct prescribed in Jainism.
4. *Nirjarā* (removal): Through the rigorous practice of the same, a Jaina sādhaka removes the karmic matter (*karma pudgala*) already present in the soul (*jīva*).
5. *Moksha* (liberation): After the complete removal of the karmic matter (*karma pudgala*), four infinites (*anantacatuṣṭaya*) of the soul (*jīva*) are revealed.

The right faith (*samyakdarśana*), the right knowledge (*samyakjñāna*) and the right conduct (*samyakcaritra*) are called the path of liberation. They are also known as three gems (*triratna*) of Jainism. The five great vows (*pañcamahāvrata*) are subsumed under the right conduct (*samyakcaritra*) in Jaina ethics. These are as follows:

1. *Ahiṁsā* (observing non-violence in thought, speech and action and compassion for all beings).
2. *Satya* (truthfulness in thought, speech and action)
3. *Asteya* (non-stealing)
4. *Aparigraha* (non-possession of things more than one's requirement)
5. *Brahmacarya* (renouncing of all passions).

These five great vows (*pañca mahāvrata*) are meant for the Jaina monks and the same has been prescribed for other people with a liberal approach and are known as *aṇuvrata*.

Jainism has a major influence on the general philosophy, culture and ethics of India. The Jaina philosophy has a great

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impact on the typical Indian concepts like *ahiṁsā, karma, mokṣa* or renunciation of *saṁsāra,* etc. M.K. Gandhi was immensely influenced by the Jaina concept of *ahiṁsā* and had developed his unique concept of practical *ahiṁsā*. The idea of Jainism is capable to bring harmony in the society in all respects.

Buddha

The seed of Buddhist philosophy is traced in the teachings of Gautama Buddha (earlier name was Siddhartha) itself. Buddha always emphasised on leading a moral life for the emancipation of human sufferings rather than indulging into philosophical problems. But, the later scholars of Buddhism developed a profound philosophy on the platform of the teachings of Gautama Buddha.

Buddha wanted to lead humanity to emancipation. Thus, to reach the masses, he used Pāli language in his teachings. These teachings have been compiled in *Tipiṭaka* (*Tripiṭaka* in Sanskrit), literally means three baskets. It is the most revered text of Buddhism. This canonical literature has three parts, viz., *Suttapiṭaka, Vinayapiṭaka* and *Abhidhammapiṭaka.*

The central theme of Buddha's teaching is inherent in the four noble truths or the truths of the nobles (*Cattāri ariyasaccani* in Pāli). These are as follows:

1. *Dukkham*: It means that there is suffering and the entire world is inflicted by it.
2. *Dukkhasamuppāda*: It means that there is a cause for suffering. It is not one entity, but a cycle of twelve links (i.e., *dvādaśa nidānacakra* or *bhāvacakra*). These are *avidyā* (ignorance), *saṁskāra* (impression of previous births), *vijñāna* (initial consciousness of the foetus), *nāmarūpa* (name and form), *ṣaḍāyatana* (six senses including mind), *sparśa* (sense-object contact), *vedanā* (sense experience), *tṛṣṇā* (thirst for the objects of enjoyment), *upādāna* (clinging to attachment), *bhava* (desire to take birth), *jāti* (birth), *jarā-maraṇa* (suffering in the form of old age and death). Each link is dependent on the previous link for its existence and gives birth to the next link. *Avidyā* (ignorance) is the root cause.
3. *Dukkhassa atikkama*: It means there is cessation of suffering. If the root cause of suffering, i.e., ignorance is dispelled, the dependent links are ceased one by one and ultimately human suffering also ceases.
4. *Ariyam Aṭṭhaṅgikaṁ Maggaṁ Dukkhupasamagāminaṁ*: It means, there is a path of cessation of suffering. The path is known as the eight-fold path. It is explained in

Gautama Buddha, Sarnath

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mahāparinibbāṇasutta of *dīghanikāya* of *Suttapiṭaka.* These paths are as follows:

(a) *Sammā diṭṭhi* (right views), (b) *Sammā saṁkappo* (right aspiration), (c) *Sammā* vāk (right speech), (d) *Sammā kammo* (right action), (e) *Sammā ājīvo* (right livelihood), (f) *Sammā vāyāmo* (right effort), (g) *Sammā sati* (right mindfulness), and (h) *Sammā samādhi* (right concentration).

One attains the supreme realisation by following the eight-fold path and the realisation annihilates the suffering by dispelling ignorance, the first link.

Buddha always preached that all beings are non-eternal and perishable so that one could be detached from the mundane pleasures. But, his doctrine of impermanence was developed as the doctrine of momentariness (*kṣaṇabhaṅgavāda*). Unlike the orthodox schools of Indian philosophy, the Buddhist philosophers refute even the permanence of self. This doctrine is known as *anātmavāda.*

The Buddhist ethics is the expansion of the fourth noble truth. Buddhism prescribes the three gems (*triratna*), viz., *prajñā* (knowledge), *śīla* (conduct) and *samādhi* (meditation) as the means of liberation. The five conducts (*pañcaśīla*) are very important for a Buddhist monk. These are:

1. non-violence
2. non-stealing
3. celibacy
4. truthfulness
5. not taking any intoxicating things like liquor.

Buddhism started from a social reform to a religion and turned into a fully grown philosophy. The early Buddhist literature was in *Pali* language and in later Buddhist era the philosophical discourses were carried out in Sanskrit language.

Buddhist religion was bifurcated later on as *Hīnayāna* and *Mahāyāna. Hīnayāna* is spread in south and south-east Asia. *Vaibhāsika* and *Sautrāntika* are the philosophical sects of *Hīnayāna. Mahāyāna* is prevalent in north and north-east Asia. *Yogācāra* and *Mādhyamika* are the philosophical sects of *Mahāyāna.* These four sects of Buddhist philosophy along with Cārvaka and Jainism constitute six schools of heterodox philosophies (*nāstika darśana*).

Buddhism has a massive impact on Indian philosophy and culture. Due to the constant dialogue and debate between these non-Vedic schools and other schools, Indian philosophy got developed. Buddhist logic is a unique contribution of the Buddhists. Along with the spread of Buddhism, Indian culture reached different countries in the world. Today, the term *pañcaśīla* used in the foreign policy of India has been coined from Buddhism.

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Āstika Philosophical Systems

The Sanskrit word *Ṣaḍ-Darśana* refers to the six systems of Indian Philosophy. They are *Sāṅkhya, Yoga, Pūrva-Mīmāṁsā, Uttara-Mīmāṁsā* (Vedānta), *Nyāya* and *Vaiśeṣika.* Each of these systems differs in one way or the other in terms of its concepts, phenomena, laws and dogmas. It is important to know that these *Āstika Darśanas* believe in the authority of the Vedas. Due to the mutual complementarity with each other, the six systems constitute the three pairs. These pairs are *Sāṅkhya-Yoga, Pūrva Mīmāṁsā-Uttara Mīmāṁsā* and *Nyāya-Vaiśeṣika. Sāṅkhya* and Yoga are complementary to each other in terms of theory and practice. *Pūrva Mīmāṁsā* and *Uttara Mīmāṁsā* are complementary to each other since the former is based on the ritualistic portion of the Vedas, i.e., *karmakāṇḍa* and the latter is based on the *Upaniṣads, Geeta* and *Brahmasūtra*, i.e., *jñānakāṇḍa.* Similarly, *Nyāya* and *Vaiśeṣika* are complementary to each other since the former is rich in epistemology and the latter is rich in metaphysics. All of these systems have been brought to the fore by a seer; often called *sūtrakāra,* i.e., the composer of aphorisms. The seers and their works are as follows:

Philosophical Systems	Seers	Works
Sāṁkhya	Kapila	*Sāṁkhyasūtra*
Yoga	Patañjali	*Yogasūtra*
Pūrva Mīmāṁsā	Jaimini	*Mīmāṁsāsūtra*
Uttara Mīmāṁsā (Vedānta)	Bādarāyaṇa *(Vedavyāsa)*	*Vedāntasūtra (Brahmasūtra)*
Nyāya	Gautama	*Nyāyasūtra*
Vaiśeṣika	Kaṇāda	*Vaiśeṣikasūtra*

Sāṁkhya

The *Sāṅkhya* or *Sāṁkhya* philosophy enjoys a unique and prime position in the history of evolution and development of almost all the philosophical trends in India. Maharṣi Kapila is unanimously regarded as the founder of *Sāṅkhya* system. He is traditionally believed to be the composer of *sūtras* of *Sāṅkhya* based upon which the system was built up. However, most of the modern scholars believe that the original *Sāṅkhya sūtras* have been lost and the *sūtras* that are available by the name of it were composed very late, i.e., in the fifteenth century.

After Kapila, the tradition is subsequently taken further by the writings of the scholars like Āsuri, Pañcaśikhā, Īśvara

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Kṛṣṇa, etc., Among them Īśvara kṛṣṇa is the most famous exponent of the system, whose *Sāṅkhya kārikā* is the first available textbook to present the philosophy of *Sāṅkhya* in an orderly and systematic way.

It is important to mention that though the tradition attributes Kapila to be the founder of the philosophy, seeds of *Sāṅkhya* thoughts are found in the scriptural and other literatures of the pre-philosophical era. One often comes across the innumerable references of *Sāṅkhya* doctrines in the *Upaniṣads* and *Mahābhārata* which were written many centuries before the time when Kapila presented it as a full-length philosophical system.

The term *Sāṅkhya* is interpreted by its exponents in various ways. Some suggest that the term is derived from the word 'Saṅkhyā' meaning 'number' and thus it signifies a system of thought that describes itself in the systematic and analytic enumeration of the principles consisting of the reality, the existence. Some scholars derive the term from the verbal root *khyā* (to see) with the prefix *sam*, which denotes an idea of philosophical reflection and ultimately it signifies a system of thought dedicated to the reflection on the distinctness of pure consciousness and matter from each other.

Like all other systems, *Sāṅkhya* also considers ignorance to be the fundamental cause of human bondage and sufferings, and it's only through the emergence of right knowledge that one can free oneself from them. And the right knowledge can be gained only by adopting the valid means of knowing.

According to *Sāṅkhya* there can be only three valid means (pramāṇas) of acquiring the right cognition which are—direct sense perception (*Dṛṣṭa/Pratyakṣa*), inference (*Anumāna*) and verbal testimony (*Āptavacana*). *Sāṅkhya* doesn't accept *Upamāna* or analogy to be a valid source of knowledge.

Sāṅkhya accepts two ultimate realities, namely, the Prakṛti or the insentient nature and the *Puruṣa* or the 'soul'. These two are eternal according to Kapila. According to the *Sāṅkhya* system of philosophy, something can never be produced out of nothing. One can see the influence of the *Nyāya* system on the *Sāṅkhya* system when it comes to the process of creation. Pleasure, pain and indifference are derived by the three 'guṇas' or 'qualities', namely, *Sattva, Rajas* and *Tamas*. *Sattva guṇa* gives rise to happiness or pleasure, *Rajas* produces pain and suffering whereas *Tamas* gives rise to inactivity.

The three qualities mentioned above reside in the *Prakṛti*, a state of perfect balance. *Sāṅkhya* says that the entire universe is born out of the *Prakṛti*. *Puruṣa* on the other

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hand is as innumerable as there are living beings. *Puruṣa* is all-pervading and eternal, that is conscious in its very essence. *Sāṅkhya* believes in the creation of the universe as a result of the union between *Prakṛti* and *Puruṣa*. The very first evolute that issues forth from the *Prakṛti* by the combination of the three *guṇas* is the *Mahat* or the cosmic intellect. Cosmic ego is born out of the cosmic intellect. There are various evolutes issuing forth from different parts of the cosmic ego characterised by the guṇas. There are a total of 25 cosmic principles of which the *Puncha Mahabhutās* are mostly referred to in modern texts. It comprises air, water, fire, earth and ether.

Yoga

Sāṅkhya and Yoga are often described as two allied systems of philosophy. Many a times these two systems are referred to as the theoretical and practical aspects of one and the same philosophy. This is well known that the Yoga system builds up its base on the pre-supposition of the metaphysics and the epistemology propounded by the Sāṇkhya school.

Patañjali (second century B.C.) is known to be the founder of Yoga system. He is the author of the *Yogasūtra*, the oldest textbook of Yoga philosophy wherein he describes the composition, nature and functions of human mind. Patañjali has outlined the scientific ways and methods of controlling the mental modifications which according to him is the only means of liberation, the ultimate goal of human life.

Aṣṭāṅga Yoga aims at the final state of spiritual absorption through eight folds, the eight limbs of Yoga. These aṅgas are *Yama, Niyama, Āsana, Prāṇāyāma, Pratyāhāra, Dhāraṇā, Dhyāna and Samādhi*. Yama aims at internal purification, *Niyāma* aims at external purity. *Āsana* consists of the performance of the postures of Yoga, *Prāṇāyāma* is breath control, *Pratyāhāra* results from the withdrawal of sense organs from the corresponding sense objects, *Dhāraṇā* is concentration, *Dhyāna* is meditation and *Samādhi* is the final state of spiritual absorption. These eight limbs of Yoga can be divided into three sets. Initial two are moral disciplines, middle three are external disciplines and the last three are internal disciplines.

The Yoga system accepts three fundamental realities, namely, *Īśvara, Puruṣa* and *Prakṛti* or the primordial matter. Patañjali says that scriptures are the sources of the existence of *Īśvara*. *Īśvara* is omniscient and is free from the qualities inherent in *Prakṛti*.

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Patanjali defines Yoga as 'Chitta-vṛtti-nirodha', i.e., Yoga is the restraint of the mental operations. Patañjali names some obstacles to the path of Yoga. They are called 'Antarāyas' and they include *Vyādhi* (illness), *styāna* (apathy), *Saṁśaya* (doubt), *Pramāda* (inadvertence), *Ālasya* (laziness), *Avirati* (incontinence), *Bhrāntidarśana* (wrong understanding), *Alabdha Bhūmikatva* (non-attainment of mental plane) and *Anavasthitatva* (instability). In addition to the obstacles mentioned above, Patañjali accepts five more obstacles called *Duhkha* (pain), *Daurmanasya* (frustration), *Aṅgamejayatva* (fickle limbs), *Śvāsa* (spasmodic breathing in) and *Praśvāsa* (spasmodic breathing out).

Nyāya

The term 'nyāya' means logic. The *nyāya* system of philosophy is the pioneer in establishing the Indian logic. It is formally established by Akṣapāda Gautama (A.D. 150) though the history of the tradition goes back to sixth century B.C. Vātsyāyana (A.D. 450) is another important scholar who wrote *Nyāya bhāṣya*, a commentary on *Nyāya sūtra* of Gautama. These two texts are the building blocks of the *nyāya* system.

The *nyāya* system believes that the world is real and our experience of the same is true. It admits sixteen categories viz., *Pramāṇa* (means of valid knowledge), *Prameya* (object of valid knowledge), *saṁśaya* (doubt), *Prayojana* (purpose), *dṛṣṭānta* (illustration), *Siddhānta* (tenet), *Avayava* (components of an argument), *Tarka* (hypothetical reasoning), *Niṃaya* (ascertainment), *Vāda* (debate), *Jalpa* (wrangling), *Vitaṇḍā* (cavil), *Hetvābhāsa* (logical fallacy), *Cala* (quibble), *Jāti* (wrong analogy) and *Nigrahasthāna* (point of defeat).

Since the attainment of liberation (*apavarga*) is the highest goal of human life, the *nyāya* philosophy shows the path for the same. The right knowledge of the twelve *prameyas* i.e., self, mind, senses, body, etc., are directly helpful to attain the liberation. But, the right knowledge of fifteen more categories is indirectly helpful for the same. Basically, all the sixteen categories are connected with logic and art of debate.

The *nyāya* accepts four means of valid knowledge viz., *pratyakṣa* (perception), *anumāna* (inference), *upamāna* (comparison) and *śabda* (verbal testimony).

The *nyāya* philosophy accepts the existence of God '*Īśvara*'. The cycle of creation and dissolution is without any beginning and the universe is created by *Īśvara* with the help of the eternal atoms, time, individual minds, space and individual selves (*jīvas*) and ether, in accordance with the past deeds of the individual selves (*jīvas*).

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This system gives an ultimate model of philosophical analysis in which any school of philosophy can be understood. In the model, all beings are subsumed under the framework of valid knowledge (*pramā*), means valid knowledge (*pramāṇa*), object of valid knowledge (*prameya*) and subject of valid knowledge (*pramātā*).

The exposition of *nyāya* would be incomplete if we do not mention the contribution of Gaṅgeśa Upādhyāya (A.D. 1320) of Mithila. He was the founder of neo-logic (*Navya-Nyāya*). For the first time, he developed an artificial language of logic for expressing the philosophical jargons with utter accuracy leaving behind even the minor possibility of ambiguity. He used the same language in his magnum opus *Tattvacintāmaṇi*. The importance of *nyāya* is evident by the fact that different philosophical schools and other disciplines too have used their logic, art of debate and the *navya-nyāya* language in their respective fields to a great extent.

Vaiśeṣika

The founder of the *Vaiśeṣika* system of Indian philosophy is Kaṇāda (A.D. 100). It is also called *Aulukya Darśana*. The tradition believes it as one of the oldest philosophies like *Sāṅkhya* in India. Praśastapāda (A.D. 400) is another important philosopher; who wrote *Padārtha dharma saṅgraha*, a commentary on the *Vaiśeṣika sūtra* of Kaṇāda. The later scholars of the *Vaiśeṣika* School have developed their ideas merely on these two texts.

The *Vaiśeṣika* system believes in the reality of the world and recognises seven 'Padārthas' or categories, which are: substance (*dravya*), quality (*guṇa*), action (*karma*), generality (*sāmānya*), particularity (*viśeṣa*), relation of inherence (*samavāya*) and non-existence (*abhāva*). In fact, the name *Vaiśeṣika* is kept because it is the one that introduced particularity (*viśeṣa*) as category. The system also believes that liberation is the supreme goal of human life. One can attain liberation through the knowledge of the similarities and the dissimilarities of these categories.

The followers of this system of philosophy also accept the existence of God and they say that the god created, sustained and destroyed the universe. According to the *Vaiśeṣika* School, the will of God is the cause for creation. He causes the combination of the moving atoms and thus is instrumental in the creation of the world. At the time of the dissolution of the universe the entire world is reduced to the primary state of the seven categories.

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The *Nyāya* and *Vaiśeṣika* have been independent systems till tenth century. But, after that a combined stream known as *Nyāya-Vaiśesika* is found. The *Vaiśesika* system is given credit to discover the atomic theory of creation for the first time. It has also influenced the Indian medicine, i.e., Āyurveda.

Pūrva Mīmāṁsā

The philosophical system of *Pūrva Mīmāṁsā* was founded by Jaimini. Mīmāṁsā believes firmly in the performance of rituals and supports the view that the body is perishable but the soul survives even after the death and it reserves the right to enjoy the results of the rituals in heaven. The school firmly believes in the preservation of the effect or the fruits of the rituals by a remarkable power. It believes that the Vedas are impeccable in what they say. It does not talk about the Brahman or the 'Supreme Entity' but says that the world is real. *Mimamsa* strictly is of the opinion that whatever we do in our life are not dreams or illusion but are real.

Jaimini accepts the two types of knowledge, namely, *Pratyakṣa* (immediate knowledge) and *Parokṣa* (mediate knowledge). Source of *Parokṣa Jñāna* is of five kinds, namely *Anumāna* (inference), *Upamāna* (comparison), *Śabda* (verbal testimony), *Arthāpatti* (postulation) and *Anupalabdhi* (non-perception). *Jaimini* accepts the plurality of soul. He says that the souls are eternal but they definitely undergo transmigration as per the actions performed by the bodies. Liberation is considered to be the highest good for humanity. Liberation puts an end to the transmigration of the soul. Performance of the daily duties brings about liberation. On the other hand the non-performance of actions or daily duties causes disruption in the path of liberation.

One of the most important observations made by the *Pūrva Mīmāṁsā* system of philosophy is that there is no need for the existence of God to create the world as well as rewarding or punishing human actions. This is because of the fact that all the material needed for the formation and the creation of the world is available eternally. Also actions have innate potency of bringing their fruits to the performer of those actions. Hence, *Mīmāṁsā* does not speak about the existence of God.

One of the major contributions of *Mīmāṁsā* has been its emphasis on the study of language hermeneutics. The system has developed a superb science of sentence interpretation. The impact of the principles of sentence interpretation can also be seen in the making and functioning of the present day judiciary system as well as other walks of modern life. This

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philosophy has a unique belief system that the *Vedas* are not human made, but self-originated.

Uttara Mīmāṁsā

The philosophical system of *Uttara Mīmāṁsā* does not have a specific founder since it is a conglomeration of three different schools of thought, namely *Advaita*, *Viśiṣṭādvaita* and *Dvaita*. The philosophical system of *Utttara Mīmāṁsā* is otherwise called Vedānta. All the three schools of Vedānta have different teachers. Ādi Śaṅkara is the head of the *Advaita* system of Vedānta philosophy. Rāmānuja is the architect of the *Viśiṣṭādvaita* system of Vedānta and Mādhva is the head of the *Dvaita* system of Vedānta philosophy.

Ādi Śaṅkara is the first philosopher who identified the philosophical truths expounded in the Upaniṣads attached to the *Vedas*. *Jaimini* gave importance to the *Karma Kāṇḍa* portion of the *Vedas* whereas Śaṅkara saw the Supreme Truth that lay firm in the message of the Upaniṣads. Śaṅkara called the world illusory as a result of Māyā or delusion. Māyā causes the illusion akin to the cognition of serpent on the rope. A person gripped by ignorance fails to see the substratum of the universe. Brahman is the substratum of the universe. It is not seen due to delusion or Māyā. Śaṅkara calls the universe an illusion and the Brahman or the Supreme Entity as Truth. Everything around us is adventitious of the Brahman. Into Brahman all creation goes. Deluge is the ultimate condition during which the Brahman withdraws all its creation unto itself.

Ramanuja advocated the *Viśiṣṭādvaita* school of *Vedāntic* thought. It is a qualified version of monism and hence is called qualified monism. Ramanuja differs from Sankara only a little in the sense that he considers the *jīva* or the individual soul as the entity different from the body and is infinite in number and cannot be one with the Supreme as long as it is confined in a body. *Mādhva,* the founder of the *Dvaita* school of *Vedāntic* thought says that the *jīvas* or the souls can attain liberation through *bhakti* and the grace of God. It is important to note that all the three teachers accepted Vedas as a valid means of knowledge.

Baring the *Cārvākas*, we observe the following salient features of Indian Philosophy:

(a) Indian philosophy is usually spiritual in its nature
(b) Indian philosophy is emanated from the experience of sufferings
(c) Religion and philosophy are intertwined and sometimes they are inseparable
(d) It is a complete and comprehensive system

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(e) It usually believes in the doctrine of karma and rebirth
(f) It is not person-centric, but a tradition-oriented system
(g) Liberation is the *summum bonum* of Indian philosophical tradition
(h) Ignorance is the root cause of sufferings
(i) The practical aspect of the Yoga philosophy is acceptable to all the schools

Indian culture is a cornucopia of different philosophical and religious sects. Following different faiths, the Indians have been living together with peace and harmony for around three thousand years. There is an inherent harmony among most of the schools of Indian philosophy. Swami Vivekanand has often quoted the verse from *Śiva mahima stotra* of *Puṣpadanta* in support of Universalist approach of Indian culture. It says — "Different paths to realisation are enjoined by the three *Vedās*, by *Sāṅkhya*, Yoga, *Pāśupata* doctrine and *Vaiṣṇava Śāstras*. People follow different paths, straight or crooked, according to their temperament, depending on which they consider best or most appropriate and reach You, alone, just as rivers enter the ocean."

त्रयी सांख्यं योग: पशुपतिमतं वैष्णवमिति प्रभिन्ने प्रस्थाने परमिदमद: पथ्यमिति चI
रुचीनां वैचित्र्याद् ऋजुकुटिलनानापथजुषां नृणामेको गम्यस्त्वमसि पयसामर्णव इवII

Śiva mahima stotra of Puṣpadanta; 7

Exercise

1. Answer in one sentence

(a) Name any three orthodox schools of Indian philosophy.
(b) Who is the propounder of *Advaita Vedānta*?
(c) What is the meaning of *Darśana*?
(d) Name any five major *Pramāṇa*s of Indian philosophy.
(e) Who is the author of *Tattvārthādhigama Sūtra*?

2. Write answers briefly

(a) What do you mean by Indian philosophy?
(b) Define *Mokṣa* according to *Jaina* philosophy?
(c) Explain the belief of *Mīmāṁsā*.
(d) What is the aim of *Viśiṣṭādvaita*?
(e) Write any major characteristic of Indian philosophy.

3. Write short notes on the following

(a) *Aṣṭāṅga Yoga*
(b) *Pañcaśīla*
(c) *Puruṣa* of *Sāṅkhya*

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(d) *Padārtha* in *Nyāya-Vaiśeṣika* system
(e) *Ārya Satya*

4. Answer in 200 words

(a) What do you mean by Indian philosophy? Give some salient features of Indian philosophy.
(b) Do you think the *Cārvāka* philosophy is more relevant to the modern world as it propagates worldly pleasure only? Comment.
(c) 'Buddha emancipates the entire humanity from suffering'—comment on the basis of Buddhist philosophy.
(d) Give a brief sketch of categories, propounded by *Vaiśeṣika*
(e) Write an essay on valid knowledge of *Nyāya*.

5. Match the columns

(A)	(B)
Śaṅkara	Yoga
Yama	Mādhava
Sarvadarśansaṅgraha	Sāṅkhya
Prakṛti	Jaina
Anekāntavāda	Vedānta

Project

1. You must have witnessed some fights or quarrels with your friends or family members or surroundings. Try to analyse the root cause of that and write a diary note explaining the philosophical principles working behind it.
2. Read carefully the *Bhagavad Gītā* and write an essay on what qualities need to be developed to become a mature person.

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Glossary

Aphorism—a short phrase that says something true or wise.

Celibacy—the state of not being married and never having sex, especially for religious reasons.

Cessation—the stopping of something; a pause in something.

Conglomeration—a mixture of different things that are found all together.

Cornucopia—a decorative object shaped like an animal's horn, shown in art as full of fruit and flowers.

Dogmas—a belief or set of beliefs held by a group or organization, which others are expected to accept without argument.

Epistemology—the part of philosophy that deals with knowledge.

Incontinence—the lack of ability to control the bladder and bowels.

Hermeneutics—the area of study that analyses and explains written texts.

Metaphysical—connected with the branch of philosophy that deals with the nature of existence, truth and knowledge.

Mundane—not interesting or exciting.

Doctrine—a belief or set of beliefs held and taught by a Church, a political party, etc.

Renouncing—to state publicly that you no longer have a particular belief or that you will no longer behave in a particular way.

Rigorous—done carefully and with a lot of attention to detail.

Seers—a person who claims that they can see what is going to happen in the future.

Spasmodic—happening suddenly for short periods of time; not regular or continuous.

Sect—a small group of people who belong to a particular religion but who have some beliefs or practices which separate them from the rest of the group.

Treatise—a long and serious piece of writing on a particular subject.

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Performing Art Traditions in India

3

Arts have always been very important in human life. Basic need of human beings to express gets communicated to others through various arts. Recent researches throw light on how during the prehistoric period people used to express through art forms. Art is a diverse range of human activities resulting out of creative skills and imagination. *Vātsyāyana* has described sixty four arts. Interestingly, in that list, the first four are performing arts—vocal music, instrumental music, dance and theatre. This also indicates that a strong tradition of Performing Arts can be traced back to the old civilisation of India. In broader sense, performing arts require skills in which the artistic expression is conveyed to the audience through performer's voice, body gestures or through sound objects or musical instruments. In everyday life, it is done through folk music, folk dance, folk theatre such as *Jātrā, Nauṭaṁki,* etc., by the common people. To practice the art in a specific specialised manner, it is referred to as the classical art forms such as, music, dance and theatre which has evolved over the centuries having a strong tradition with laid down rules and regulations.

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Do you know that classical music has evolved from folk music. This signifies the strong connection between the two.

Source: *Pragetihasik Bhartiya Chitrakalaa Mein Sangeet*

Performing arts occupy a significant place in the Indian society. There can be no doubt about the fact that art forms, be it performing or visual, reflect the thinking process of

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Source: *Pragetihasik Bhartiya Chitrakalaa Mein Sangeet*

the society which comprises its people, their habitat, ethos, emotions, and uniqueness of communities and surroundings.

Music in India

Indian music, i.e., *Bhāratīya Saṅgīta* has built a strong background over different occasions simultaneously enriching our culture. It has a rich treasure of classical, regional and folk forms expressed through vocal music and instrumental music. Music comprises three art forms, i.e., *Gīta, Vādya* and *Nṛtya* as referred in *Saṅgīta Ratnākara* written by Pt. Sharangdev "गीतं, वाद्यं त्रयं संगीतमुच्यते" In *Saṅgīta Pārijāta*;, Pt. Ahobal has said: "गीतावादित्रनृत्यानां रक्ति साधारण गुणः अतो रिक्तविहीनं यत्न तत् संगीतमुच्यते ".

Indian Music has been continuously affected by the social and religious conditions. It has gradually evolved through different periods and stages. The development of Indian music can be classified into three main periods:

1. Ancient Period
2. Medieval Period, and
3. Modern Period

Ancient Period (2500 B.C.–A.D. 1200)

The origin of Indian music can be traced back to evidences from the Indus Valley Civilisation. This period is also known as Vedic period. During this period, the Vedic hymns were chanted and some of them were also set to tune and rhythm. The rhythmic recitations of *Ṛgveda* were known as *Ṛcās* (ऋचायें). *Sāmaveda* is the compilation of these selected *Ṛcās* set to *Svaras* keeping their proposed *Chanda* (छंद) or rhythmic meters. Only three *Svaras* — *Udātta* (उदात्त), *Anudātta* (अनुदात्त) and *Svarita* (स्वरित) were used in *Sāmagāna*. *Udātta* was the sharp pitch, *Anudātta* was grave pitch and *Svarita* combined in itself the characteristics of both the pitches.

In Pāṇinīya Śikṣā, Pāṇini has mentioned two additional *Svaras* — 1. Uccaistara, higher than the *Udātta* and 2. *Sannatara* lower than the *Anudātta*. Further, seven notes evolved from these three Vedic *Svaras*. According to *Pāṇinīya Śikṣā*:

"उदात्ते निषाद-गांधारौ, अनुदात्ते ऋषभ-धैवतौ
शेषास्तु स्वरिता: गेया: षड्ज-मध्यम-पंचमाः"

which means *Niṣāda (Ni,* the seventh *svara)* and *Gāndhāra (ga,* the third *svara)* arise from *Udātta; Ṛṣabha (Re,* the second *svara)* and *Dhaivata* (*Dha,* the sixth *svara*) arise from *Anudātta;* and *Ṣaḍja (Sa,* the first *svara*), *Madhyama (Ma,* the fourth *svara)* and *Pañcama (Pa,* the fifth *svara)* originate from *Svarita*.

Dancing Shiva

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- *Mantras* chanted during religious activities with *Svaras* were known as *Sāmagāna* (सामगान).
- Seven *Svaras* (notes) evolved from three basic *Svaras* of *Sāmagāna.*
- *Sāmagāna* was sung in three different pitches with a variety of intonation used during recitations by a group of singers known as *Sāma Gāyakas.*
- Musical Instruments like *Ghoṣa, Vīṇā, Kaśyapī, Audumbarī, Veṇu, Dundubhi, Puṣkara, Tunāva, Āḍambara,* etc., were in practice.

There are two streams of music known as *Mārgī* and *Deśī*.

1. *Mārgī* or *Gāndharva Saṅgīta* was practiced for salvation.
2. *Deśī Saṅgīta* which was further divided into classical, semi-classical, folk music, etc.

Gradually *Sāmagāna* developed into *Gāndharva* which was further developed during the *Rāmāyaṇa,* the *Mahābhārata* and *Purāṇas.*

The epic *Rāmāyaṇa* composed by *Vālmīki* has the reference of terms like *Saṅgīta, Svara, Laya, Tāla, Mātrā, Mūrchanā, Jāti, Mārg Saṅgīta* and *Gāndharva.* The reference of musical instruments is also available in the epic, such as, *Vipañci, Vallakī,* etc. *Mahābhārata* written by *Kṛṣṇadvaipāyana Vyāsa,* has musical terms such as *Grāma, Mūrchanā* and the names of seven basic *Svaras* such as *Ṣaḍja, Ṛṣabha,* etc. It also has the reference of musical instruments used during this period, such as *Bherī, Jharjharī, Tūrya, Vīṇā,* etc.

1. Let us find a few *ślokas* of the Vedic period along with their meaning which we recite even today.
2. What are the musical evidences available in Vedic period and the epics—*Rāmāyaṇa* and *Mahābhārata.*

Bharat's Nāṭyaśāstra is the most important and pioneer work of music, dance and drama. It has 36 chapters, out of which six chapters (28th–33rd) are related to music. *Śruti, Grāma, Grāmarāgas, Jāti, Mūrchanā, Gīti, Alaṅkāra,* etc., have been discussed in depth in the book. *Dhruva Gīta* had a special place in *Nāṭya.* These were used in between different scenes called *Nāṭya Sandhis.* Concept of *Rasa* for aesthetic experience has also been discussed elaborately in *Nāṭyaśāstra.* This is the first text available on the classification of Indian Instruments.

Raag Mala Chitra: Bhairvi
Source: Centre for Cultural Resources and Training (CCRT)

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Loka Vādya

Classification of Indian instruments

1. *Tat* (string instruments)
2. *Suśīrā* (wind instruments)
3. *Avanādha* (percussion instruments)
4. *Ghana* (instruments made of brass or wood)

In Mataṇga's *Bṛhaddeśī* (seventh to eighth centuries), we get to see the description of *Deśī Rāga* for the first time.

Mataṇga was the first to place frets (परदे) on the *Kinnarī Vīṇā*. The concept of Time Theory of *Rāgas* was first mentioned by Nārada in *Sangīta Makaranda* (eighth to ninth centuries). The other important Treatises of ancient periods are *Nāradīya Śikṣā, Sangīta Makranda, Dattilam, Gīta Govinda, Sangīta Samayasāra and Sangīta Pārijāta.*

1. Did you notice the evolution of music from the Vedic period to second century? Mention some of the noticeable changes.
2. Name three Vedic *Svaras* which were used in *Sāmagāna.*
3. How many basic notes (*Svaras*) are there in Indian music?
4. Who is the writer of *Nāṭyaśāstra*? How many chapters does it contain?

Guru-Śiṣya Paramparā or the Oral Tradition

Music in India has been passed on in a tradition described as *Guru-Śiṣya Paramparā* (teacher-disciple tradition). In the *gurukula* system of education (from the Vedic Era to the medieval era), a pupil or *śiṣya*, after his initiation (sacred thread ceremony), lived in the house of his guru, or teacher, and studied the *Vedas* and other subjects under his guidance, for a period of 12 years. Gurus were expected to teach everything they knew to the disciple. The *Gurukula* was the precedent of the concept of *gharāna* in Hindustani music from the eighteenth to twentieth century, the difference being, in a *gharāna,* the learning was strictly in music and dance in a particular style or *śailī*. Knowledge in dance and music was passed on from one generation to the other through this oral tradition, there was no written word or process of documentation in earlier times. It evolved through successive generations. Even in the present times, music and dance classical traditions are learnt in the *guru-śiṣya paramparā*.

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Medieval Period (A.D. 1201 – A.D. 1800)

The medieval period is known for the development of musical forms, musical instruments and documentation of music in a vast number of authentic texts which are available in the shape of *Grantha* (ग्रन्थ) to understand the growth of classical music.

Śāraṅgadeva (A.D. 1210–1247) was the author of the important musicological text *Saṅgīta Ratnākara.* In this text, the author describes *Saṅgīta* (music) as a composite art consisting of *Gīta* (melodic forms), *Vādya* (forms for drumming) and *Nṛtya* (dance, literally movements of the limbs of the body). *Saṅgīta* is of two kinds—*Mārga-saṅgīta* and *Deśī-saṅgīta*. The music for the mass was *Deśī Saṅgīta*. The construction and techniques of playing musical instruments like 14 kinds of drums and other rhythm-instruments have been vividly discussed.

In the medieval period, with the advent of Muslims, classical music in India began to evolve as two distinct traditions — (i) Hindustani Music and (ii) Carnatic Music. Hindustani Music spread to northern, eastern and western parts of India and Carnatic Music to the whole of Southern or Deccan Plateau region. There was a difference in the language, singing style, *svarsthānas,* rhythmic (*Tāla*) patterns and melodic structures owing to regional contexts and political changes. Both temple music and *Darbārī Saṅgī ta* came into being in the northern region. The classical tradition of Southern India maintained its purity and tradition restoring it in the sanctity of the temples. Many Indian and non-Indian cultures took an active part in this transformation. The advent of Islam at the end of the twelfth century brought Persian music and culture in the northern, eastern and western parts of the country. Personalities such as Amir Khusro, Raja Man Singh Tomar, Mian Tansen, Swami Haridas, Baiju Bavra, Gopal Nayak contributed in the development of Hindustani Classical Music during this period.

In the *Bhakti* movement, literature and music played a major role in propagating philosophies of human life. The works of composers like Jayadeva (eleventh century), Vidyapati (A.D. 1375), Chandidas (fourteenth to fifteenth century), Bhakta Narasimha (A.D. 1416–1475) and Meerabai (A.D. 1555–1603), Kabir and Tulsidas (fourteenth and fifteenth century), Surdas, Vallabhacharya and Chaitanya (seventeenth century) had a very strong impact on music traditions and practices during this period.

Musician: Mughal Painting of 17th Century
Source: CCRT

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Rāgiṇī Basant
Source: CCRT

Development of musical forms

In ancient period, *Jāti Gāyana* developed into *Prabandha gāyana*. Later in medieval period musical forms like, *Dhrupada, Dhamāra, Khayāl, Tarānā,* etc., evolved from *Prabandha*. Music which was accompanying drama had evolved now as an autonomous art form. New styles in instrumental music such as *Masītkhānī* and *Rāzkhanī* were developed in the medieval period. Pt. Somnath in his text *Rāga Vivodha,* described two fold description of *Rāga,* i.e., *Devamāyā svarūpa* (describing ethos of the *Rāga*) and *Nādamaya svarūpa*—tonal structure of the *Rāga*. *Rāga's* poetic description for better understanding of the ethos of a *Rāga*, lead to the creation of *Dhyāna Mantras*. These *dhyānas* were later depicted through *Rāga-mālā* paintings.

Rāgas were evolved from *Jāti lakṣaṇa.*
Jāti lakṣaṇa were adopted as *Rāga lakṣaṇa.*
Every *Rāga* has set number and sequences of *Svaras.*
In medieval period *Rāga dhyāna* tradition emerged.
Rāgas are performed according to the time prescribed to them.
There are different varieties of classification of *Rāgas.*

Many new instruments like *Sitār, and Tablā* were developed. Amir Khusro, a very famous musician, is believed to have evolved many musical forms like *Qawwālī, Qual, Kalbana,* etc., *Rāgas* like *Yaman, Sāzgirī, Tālas* such as *Chapaka, Fartost,* etc. Under the patronage of kings, artists were encouraged to practice the intricacies of musical forms to refine their skills to higher levels of perfection. Gradually, musical forms started developing their traditions and styles by the efforts of practicing artists. This resulted into establishing *'Gharānā System'. Gharānā* is a term used to explain the belonging to a legacy of musical traditions either by lineage or by practicing a particular musical style. Every *Gharānā* has its own distinct features which emerge from mannerism and application. The concept of *Guru-Śiṣya* (Teacher-Pupil) leads to the sustainability of *Gharānā.*

Teaching in *Gharana* system is based upon oral tradition (*Guru-Śiṣya Paramparā*).
Gharana must have three generations to attain recognition.
There are many *Gharānās.* One of the important *Gharānās* is named after Mian Tansen—the famous court musician during Akbar period.

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Modern Period (A.D. 1800 – Till date)

In this period, Indian music flourished in the courts of kings. Few foreign scholars such as Sir William Jones, Sir W. Ouseley and Captain C.R. Day, Captain N.A. Willard showed a great aptitude for Hindustani Music and they wrote many valuable books on music. During this period Muhammad Raza (1813) wrote an important treatise *Naghmat-e-Asafi*. He is believed to be the first to adopt the *Bilawal Scale* as is *Shuddha Scale*.

Pt. V.N. Bhatkhande and Pt. V.D. Paluskar worked hard for the upliftment of music and musicians by organising music conferences, establishing music institutions and writing books. Efforts were made by Pt. V.N. Bhatkhande and Pt. V.D. Paluskar for documentation of music by evolving systematised Notation System.

This period is known for a revolutionary change in field of music introducing it in formal education system. Many scholars of this period have worked hard to get recognised as a discipline parallel to other disciplines.

Famous musicians of Modern period are Balkrishna Bua Ichalkaranjikar, Ustad Faiyaz Khan, Savai Gandharva, Inayat Khan, Barkatulla Khan, Mushtaq Ali Khan, Nissar Hussain Khan, Allaudin Khan, Bade Gulam Ali Khan, Krishna Rao Shankar Pandit, Acharya Brihaspati, Omkar Nath Thakur and Vinayak Rao Patvardhan.

Pt. V.D. Paluskar started Gandharva Mahavidyalaya in Lahore (at present Pakistan).

Pt. V.N. Bhatkhande started Marris Music College in Lucknow, Uttar Pradesh, India.

Pt. V. N. Bhatkhande introduced *Thaat Raga Paddhati.*

Theatre

As a child all of us have played ghar-ghar (playing house). This way we playfully observed, imitated, became any character of choice, and had great fun. This is often referred as dramatic instinct in human beings. Drama is derived from a Greek word 'drama' meaning 'to do', 'to act'. Aristotle defined it as 'imitated human life'. Drama is also often called 'play' (*khel* or *natak khelna* in Hindi). Adults also play drama albeit in different ways. All of us play multiple roles in day-to-day life: one single person playing the role of a mother at home, teacher at school, passenger in a bus, etc. This may be called role play in real life. In formal theatre, drama is enacted on stage and there are two groups who participate—(i) actors and (ii) audience.

Dramatic enactments have been part of communities from prehistoric times, and each civilisation had developed

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its own norms of theatre. "The origin of Indian drama, as of significant drama anywhere else in the world, probably lies in the tribal ritual dances and celebration of antiquity. What began as community participation would gradually break down into two groups—those who perform and those who watch, that is the actors and the audience".—Som Benegal[1]

In India, there developed a rich tradition in theatre, particularly the classical Sanskrit drama. *Natyaśāstra*[2], ascribed to Sage Bharata, the oldest treatise on dramaturgy, gives an interesting account of the origin of Indian *Nāṭya* tradition in the opening chapter.

Mythological Story on the Origin of Indian Theatre

It is said that the four *Vedas*—as repository of knowledge and wisdom were accessible to upper castes and classes (*Vaṃas*), and not to women and lower caste or class. Dissatisfied with this situation, the Gods went to Brahmā, the creator, for a solution. The creator suggested the creation of the Fifth *veda* (*Pañcamaveda*) as *Nāṭyaveda.* This task was accomplished by Sage Bharata by way of extracting the wisdom of *Rigveda*, performative rituals of *Sāmaveda*, musicality of *Yajurveda* and emotive representations of *Atharvaveda.* The voluminous work, thus created, embodied all physical, theoretical and conceptual ideas behind traditional Indian drama. *Nāṭyaśāstra*, thus, speaks about the thought process and behaviour of people, their temperament, problems in society, needs, sorrow, etc., paving the way and promise for a better life.[3] It is recommended to go through important texts written by Shaktibhadra, Neelakantha Kalidasa, Bhattanarayana, Viswanatha and Kaviraja, who incorporated elements of *Nāṭyaśāstra* in their original writing.

Nāṭyaśāstra was written around the A.D. second century. According to the text (Chapter 35), a theatre group should have persons specialised in seventeen types of works: *Bharata* (Manager or producer or a multidimensional person), *Vidūṣaka* (Jester), *Tauripta* (experts in playing musical instruments), *Naṭa* (actor-Dancer), *Sūtradhāra* (linking and interpreting the text), *Nāṭyakāra* (the playwright), *Nandī* (in praise of the Creator while invocating the play), *Nāyaka* (person in lead character), *Mukuṭakāra* (Mask makers), *Ābharaṇakāra* (person engaged in making ornaments for a performance), *Mālyakāra* (person engaged in making garlands/ornaments), *Veṣakara* (costume makers), *Chitrakāra* (painter/artist), *Rajaka* (person engaged in cleaning the costumes), *Kārukara* (sculptor-decorator) and *Kuśīlava* (actors in role proficient as actor-dancer-musicians). This list helps us to understand the components of a theatre group. Interestingly Nāṭyaśāstra includes names of each and every allied work considered necessary for a performance. For that reason, the *Rajakas* or *Mālyakāras* were honoured as a member of a theatre group, although they were not directly related to performances.

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1. Think: While reading the above paragraph of specialised people connected with different types of work for theatre, what comes to your mind?
2. Imagine as if you are in the second century and discuss whether in your opinion we who live in the twenty first century—are we a developed society?

The early drama was a combination of mime, poetry, prose, dialogue, humour, songs and dance. This made theatre as an all inclusive art form. Gradually it became an important medium for entertainment, learning, communication and reflexive thinking on human conditions.

The tradition of theatre in India certainly developed much before *Nāṭyaśāstra*; but systematic thinking or theorising about theatre arts started taking shape with *Nāṭyaśāstra*. It is believed that *Nāṭyaśāstra* had developed by compiling and conceptualising the prevailing folk traditions. The dramatic representations were conceived in three distinct forms; *Nāṭya* or the verbal act inclusive of singing; *Nṛtya* the non-verbal mimetic language, and *Nṛtta* or the language of body or dancing. For Bharata, the composite term *Abhinaya* would mean—*Abhi,* meaning learning from the play and *ni,* meaning to carry it forward. It intends to entertain and educate people simultaneously. When we talk of arts intervention in education today, we must critically judge its implications in the present times.

Ancient drama tradition can be categorised in two ways—*Nataka* which is *lokadharmi* or popular, and *nāṭyadharmi* or conventional. Sanskrit plays had a *Sūtradhāra* who created a link of events in a play through commentary, musical interlude or interpretative extempore.

Nāṭyaśāstra was written in Sanskrit. Kalidasa, the most celebrated poet of the Gupta era, wrote plays in Sanskrit and followed the *Nāṭyaśāstra* tradition. This establishes the fact that *Nāṭyaśāstra* was a pre-Gupta text. Another important point to be noted is the aspect of dependence of Sanskrit theatre on royal patronage. Necessarily, the audience of this theatre was social elite.

Interestingly, in Sanskrit drama characters could speak differently in classified dialects. The hero or the principal male characters speaking in Sanskrit; the heroine and principal female character in Prākṛt; the royal attendants, servants and traders, rogues and villains, intriguers, cowherds, the people of the forest, and so on, in their respective dialects. This reveals the social categorisation of people of that time[4].

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Ashvaghosha

One can count about 35 plays from the classical Sanskrit genre but there are many more mentioned by others that are yet to be discovered. All the available ones are not classics.

Ashvaghosha

Palm-leaf fragments found in Central Asia take us back to the Kushan period of the A.D. first century. The earliest Sanskrit play, an unfinished one, comes in the form of a nine-act Buddhist play by Ashvaghosha, the court poet of the Kushan King Kanishka. This earliest Sanskrit play is called *Sāriputra Prakaraṇa*. Kalidasa, the most recognised poet-playwright who lived sometime in the fifth century in the glorious Gupta period of Indian history penned such classics as *Mālavikāgnimitram*, and *Abhijñāna-Śākuntalam* which are performed even today. Shudraka wrote *Mṛcchakatikam,* which is undoubtedly a masterpiece. Vishakhadatta's *Mudrārākṣasam* was written two hundred years later in the A.D. ninth century. One must remember Bhavabhuti, a scholarly Brahmin, proficient in rhetoric and logic, has left three works: two of which may be called historical-mythological—*Mahāvīra-caritam* and *Uttararāma-caritam*—both dealing with the Ramayana, and the third with a romance titled *Mālati-Mādhavam*. The Sanskrit plays of Bhasha, Kalidasa, Shudraka, Harsha and Bhavabhuti complete a representative cross-section of Sanskrit drama.

The glory of Sanskrit drama declined through ninth to twelfth centuries, in the face of political turmoil. The language was also a big factor of its losing popularity.

Sanskrit Play

The decline of Sanskrit drama did not mean the decline of drama of Indian theatre. The growth of the *Prakṛts* made Sanskrit rather irrelevant and these popular languages threw up their own literatures and with it came a trend of powerful folk theatre tradition which survived the varied time and periods of history. This trend of theatre survives right down to this day in many parts of the country.

We find a few references of Urdu theatre in the court of Wazid Ali Shah who was a great patron

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of all performing arts. Although the ancient literature of the South, notably Tamil literature, has many references to drama and dramatic performances, there is little evidence of written plays with authorship. A form known as *Kuttu* meaning play or entertainment is found in Tamil literature. The *Kuttu* persists to this day in many forms of folk. There is the *therukuttu* form which appears to be a wholly rural artistic tradition. The most splendid and enduring contribution of the South to Indian theatre is storytelling traditions through dance and dance-drama. Notable among these are: *Bharatanatyam*, *Kathakali*, *Bhāgavata Mela Nāṭakam*, *Yakṣagaṇa* and *Kuchipudi*. The *Bhāgavata Mela Nāṭakam, Yakṣagaṇa* and *Kuchipudi* are said to be the regional variations of Indian Classical Theatrical tradition and they are sturdily dramatic in form employing special dazzling elaborate costumes and make-up. Although the *Bhāgavata Mela Nāṭakam* originally came from Tamil Nadu, its greatest manifestation is found in Andhra Pradesh which is also the home of *Kuchipudi*. On the contrary, *Kathakali* is a product of Kerala and perhaps the most vigorous and dramatic of all Indian dance-drama forms. The essence of all these dramatic forms is in the intersection of drama, dance, mime, gesture and music. In that sense, it may be considered as excellent examples of theatre *in toto*.

Sanskrit Play

Modern Developments

With the coming of the colonial rule, we find a strong influence of western, particularly English theatre tradition in the making of modern Indian theatre. It had interesting features: though essentially urban, it incorporated many classical and folk features and it simultaneously helped in the rise of commercial theatre and played a crucial role in raising nationalist sentiments. One may mention the names of Girish Chandra Ghosh and Bharatendu Harishchandra

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in this context. What followed was a good mixture of entertainment, nationalism and social reform.

One interesting development was Bombay Parsi theatre. Its initiator was a shrewd and resourceful man named Pestonji Framji who started the 'Original Theatrical Company' around 1870. His success led to the establishment of as many as six other flourishing companies, some of them breakaways from earlier groups. Although Bombay was their base, these companies travelled widely over North Indian and one of them, the Victoria Theatrical Company of Khurshidji Balliwala, even ventured as far as Britain.

We find simultaneous development of Bengali, Marathi, Kannad and other regional theatres together with the revival of many classical forms particularly in dance drama theatre. From 1930s to post independence period saw the rise of innovative forays theatre, music and dance. Uday Shankar's ballet, Rukmini Devi Arundale's Kalashetra attracted international attention and the rise of Indian People's Theatre Association (IPTA) changed the face of modern theatre forever.

Drawing upon the classical, folk and world theatre practices, IPTA paved the way for experimentations in developing new form and content in tackling emerging realities of post independent India. IPTA had inspired an enormous body of talents who subsequently enriched all the art fields including dance, music, literature, theatre and even cinema.

Mention may be made of some post independent personalities who shaped the contemporary Indian theatre: Sombhu Mitra, Chandrashekhar Kambar, Utpal Dutt, Habib Tanvir, Badal Sarkar, Mohan Rakesh, K.N. Panikkar, Vijay Tendulkar, Ibrahim Alkazi, Ratan Thyam, Girish Karnad, to name only a few. To understand the very recent developments in Indian theatre, one needs to study and understand the specific contributions of these people. We also need to look into the way Saṅgīta Nātaka Akademi and National School of Drama — two Government institutions, have played their roles in shaping contemporary Indian theatre. In recent years, theatre is playing interesting role in connecting education and social action.

Yakshagana performance

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We also need to appreciate the role played by folk theatre in shaping our Indian sensitivities—*Bhavai* from Gujarat, *Tamasha* from Maharashtra, *Bhand Pather* of Kashmir, *Jātrā* of Bengal, *Nautanki* of North India, *Yakṣagaṇa* of Karnataka, to name only a few. These are adding to the meaning of Indian theatre.

Dance in India

Dance is perhaps the oldest of all the living art forms of the human race. In fact cave paintings of prehistoric times display stylised movements or dance, conveying daily activities such as hunting, food gathering, enjoyment, etc. Images excavated from the remains of ancient civilisations give us valuable information about the history of our dance, such as the figurine of a bronze dancing girl which has been found in the Indus Valley civilisation relics.

Dancing Girl figure made of bronze
Source: https://nroer.gov.in

Dance in India has been an integral part of every social and cultural event. In a country such as ours, in which people of different races, languages and culture reside, there is a wide variety of forms in dance. Dances performed in India are believed to have their origins in dances and rituals of the period of the *Vedas*, which date back to around 5000 B.C.E. Bhimbetka Caves in the Vindhya Hill region of Madhya Pradesh are filled with images made by hunter-gatherers of dancers in various poses and group choreographies. Rather, as with most other branches of knowledge, its origin is ascribed to divinity. *Naṭarāja* or *Śiva* in the image of the Lord of Dance is revered as the supreme dancer. Some of the ancient treatise on dance and drama is the *Nāṭyaśāstra*, *Abhinaya Darpana*, *Nartana Sarvaswam*, *Rāmāyaṇa*, *Mahābhārata* and *Harivaṁśa*. Recorded evidences of dance have been found from the study of Anthropology, Archaeology, Sculpture, Paintings, Inscriptions, Religious and Secular Treatises and Literary Works.

Paintings of Ancient and Medieval India are also a storehouse of knowledge for the dance historian.

Gestures, body postures, expressions, etc., are the basic elements of Indian dance. The use of the hands and fingers (hand gestures called *mudrās*), eyes, head movement, formation or creation of different forms and shapes to the body are of primary importance in any dance form. The costume is of extreme importance where the clothes, jewellery and make-up showcase the identity of a particular place or region of India, e.g., in Bihu dance we see the men and women wearing typical Assamese dresses like *mekhola chaddar*, dhoti, whereas in the state of Rajasthan we find dancers wearing *lehenga* and *chunri*.

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The *Navrasas*— All forms have traditionally been structured around the nine *rasas* (emotions), which are *Śṛṅgāra* (love or beauty), *Hāsya* (laughter), *Karuṃā* (sorrow), *Raudra* (anger), *Vgīra* (heroism or courage), *Bhayānaka* (terror or fear), *Bibhatsa* (disgust), *Adbhūta* (surprise or wonder), and *Śānta* (peace or tranquility).

The essential elements of Indian dance are:

- the technique of movement, which includes facial expressions, head movements and body movements.
- all types of vocal and musical instruments and literature from Hindu mythological and ancient texts linked with dance.
- costumes, make-up and sets.

There are certain features that are common to all these dance styles. They all incorporate the three elements of Nartana or dance which are *Nṛtta* (pure dance) or abstract, Nṛtya or expressive and Nāṭya or dramatic dance. Being a communicative art forms, the role of abhinaya is very important which means 'to carry across ideas to the audience'. Sentiments, feelings and even moral precepts are carried across. Abhinaya is of four kinds:

Āṅgikābhinaya comprises of movements of the body or aṅga.

Vāchikābhinaya consists of *vachana* or words, songs, speeches and narration.

Āhāryābhinaya includes costumes, jewellery, make-up, stage props and setting, that which has been acquired or āharita.

Sātvikābhinaya includes inner spiritual feelings, emotions and psychic states—expressed in a visible outward form.

1. What are the basic elements of dance?
2. View two different types of photograph of dancers or click two photos. Note the uniqueness in each.
3. Did you go to a historical monument and see sculptures of dance? Write a note in about 150 words.
4. Learn the *Navrasas* and recite them. Reflect whether these *rasas* fabricate your life.

The oldest evidence of Indian dance are descriptions of dance found in Barhut, Sanchi and Amaravati, which dates back to the second century B.C.E. Sculptures from all over India illustrates the importance of dance in Indian history and the richness of its traditions. It is said that Gautam Buddha, while being a king, had dancers, singers

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and instrument players in his court. In the case of Ajanta and Ellora, the paintings depict various mudrās of dances. During the classical Gupta age from the A.D. fourth to sixth century many sculptures give evidence of dance. The plain outer walls were decorated with narrative panels as well as dancing divinities. This was the beginning of a development that was to lead to the flourishing of dance images in Hindu temple architecture. During the so called 'medieval' period, approximately from the seventh to the sixteenth century, the most abundant representations of dance images can be seen in the Hindu temples of South India, in the Bhubaneshwar temples in East India, and in the temples of Khajuraho in central India. The West Indian Jain temples of Mt. Abu are also famous for their dance imagery.

One of the famous carvings of ninth century gateways is the Shiva temple in Chidambaram. What makes these Chidambaram *karana* reliefs so particular is that they are accompanied by the inscriptions of Sanskrit verses from the *Nātyaśāstra* (a Sanskrit text on performing arts by Bharat Muni estimated to be written between five hundred B.C.E. and five hundred C.E.). Thus they form a kind of an illustrated dance manual carved in stone.

Many classical forms of dances are based on ancient sculptures. India has a very rich tradition of classical, tribal regional and folk dance forms. Our community life vibrates with singing and dancing. The birth of a child, weddings, festivals, the harvest, different seasons, or just the leisure that a field-worker enjoys at the end of the day, are occasions that call for dance as a celebration.

Living dance traditions

Tribal Dance

The dance of primitive and tribal groups generally performed by nomads who are close to nature fall in this category. Primitive ritualistic dance forms such as those of the Santhals, the Theyyam of Kerala in which masks of tigers and lions are used, the dance of the *Kalbelia* people who are the snake charmers of Rajasthan, the fire dance of Rajasthan and Gujarat, etc.

There are also certain Martial Art Dance forms like Kalaripayattu from Kerala, Gatka from Punjab, Mardani khel from Maharashtra and the like.

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Folk dances

These originated when humans started cultivating crops, and hence had to stay in fixed area and settlements. The dances centered around the agricultural calendar, especially the harvest and also around social events such as marriages, child birth and death. Dances of this category are the *Bihu* of Assam, the *Dandiya Raas* and *Garba* of Gujarat, the *Bhangra* of Punjab, the *Chari* of Rajasthan, etc.

The tribal and folk dance forms are basically participative dance forms in which everyone takes part and there is no distinction between the artist and the audience.

Classical Dances

Classical dances are sophisticated dance form polished by the intellect of accomplished artists and teachers who belong to intellectual or knowledgeable society.

Modern Dance

There are new styles of dance being evolved by accomplished dancers who are trained in the forms and aesthetics of the classical styles. This has also been termed as Creative, Innovative and Modern Dance.

Classical or Traditional Dance Forms of India

It is believed that these dances originated around the time when Janapadas were founded in India. They convey refined techniques of dance, story or message. Each classical dance form varies according to regional differences, social conditions, language, music, costumes, and of course, the individual contribution of artistes and teachers. The major classical or traditional dances of India, as accepted today, are:

1. Bharatanāṭyam
2. Kathak
3. Kathakali
4. Manipuri
5. Odissi
6. Kuchipudi
7. Mohiniattam
8. Sattriya

Kathak

A dance form with its roots in the northern part of India, it derives its name from the word *Katha*, or story. The journey from the rustic, wandering minstrel, to the storyteller of

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the temples of North India, through the courts of emperors and kings to the modern proscenium stage—the journey of Kathak is long and diversified. Lucknow Gharana, Jaipur Gharana, Banaras Gharana and Raigarh Gharana are the main gharanas or styles of Kathak.

Kathak Dance

Bharatanāṭyam

This dance form originated in southern part of India in the state of Tamil Nadu. It started as a temple dance tradition called Dasiyattam (the dance of the maid-servants) 2000 years ago. The name Bharatanāṭyam is a simple derivation from the four most important aspects of dance (in Sanskrit). These are: *Bha* from *Bhāva* meaning emotion, *Ra* from *Rāga* meaning music or melody, *Ta* from *Tāla* meaning rhythm and *Nāṭyam* meaning dance.

Bharatanatyam

Source: https://nroer.gov.in

Odissi

This dance form takes its name from the state of its origin, Odisha. It is approximately 60 years ago that Odissi, took its present form as seen today. Today's Odissi has evolved from the endless sculptures in various motifs carved on the temple walls of Orissa. Tribhangi, a unique posture in the form, literally meaning three bends in the body is inspired by temple sculptures creating an illusion of sculpture coming to life.

Kathakali

This is a dance form of Kerala which dates to around the seventeenth century and has become the most recognised icon of Kerala. The word Kathakali literally means 'story-play'. Kathakali is known for its heavy, elaborate make-up and costumes. This dance form presents themes derived from the Hindu epics, mythologies and legends. Initially Kathakali was thought to be the sole domain of men but now women also perform the dance.

Mohiniattam

Mohiniattam, the female dance form of kerala with its origin in the temples of Kerala was shaped to its present form by the Travancore Maharaja Kartika Thirunal and Swati Thirunal around nineteenth century. The dance form which was lost, was revived in through the dedicated efforts of Vallatol in twentieth century. *Lāsya* (languid grace) and Śṛṇgāra (beauty and love) are the essence and the basic mood of Mohiniattam. In Mohiniattam, it is compulsory to wear white costumes.

Odissi

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Kuchipudi

1. Imagine you are a storyteller and express an incident around you non-verbally.
2. *Do you know any Bharatanatyam dancer? Interact with them or interview them and give a report.*
3. *Name five* Odissi dancers, *and make a presentation on them.*
4. Find out about the costume and elaborate make-up of Kathakali.

Kuchipudi

This is a dance style adapted from the dance dramas enacted by Brahmin priests or *Bhagavutulus* whose dance was again influenced by the style of the Rājanartakīs or women court dancers of the time. The dance style is named after the place of its origin—Kuchipudi, a quiet village, about 65 kilometers from Vijayawada in Andhra Pradesh.

Manipuri

The classical dance of Manipur—the Jeweled City, is associated with Pre-Vaishnavite and Vaishnavite tradition. This dance form is a unique blend of Saṅkīrtana and Rāsalīlā. The dance with the drum called *Pung,* is one of the most vibrant and exciting presentations in Manipuri dance.

Sattriya

Sattriya

Sattriya or *Sattriya Nṛtya*, originated in the eastern state of Assam. It is a dance-drama performance art with origins in the Krishna centred Vaishnavism monasteries of Assam, and attributed to the fifteenth century Bhakti movement scholar and saint Mahapurush Srimanta Sankardev. One-act plays of *Sattriya* are called *Aṅkīya Nat*, which combine the aesthetic and the religious through a ballad, dance and drama. The plays are usually performed in the dance community halls (*namghar*) of monastery temples (*sattras*). The themes played relate to Krishna and Radha, sometimes other Vishnu *avatāras* such as Rama and Sita.

New styles of dance are being evolved by accomplished dancers who are trained in the forms and aesthetics of the classical styles. These have variously been termed as Creative, Innovative and Modern Dance. Creative genius like Uday Shankar, Chitralekha, Narendra Sharma, etc., evolved their own dance style taking the best from classical and folk dances and blending mythological and modern themes to suit the tastes of the modern audience.

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It is Rabindranath Tagore's efforts that made dance in India a socially acceptable art form. Tagore actively promoted dance and composed songs and dance dramas which he helped to choreograph and stage. He encouraged his students to learn various forms of dance and portray them with involvement and grace.

Some Folk forms (Performing Arts) of India

Have you heard of these Folk Dances of India—*Kalbelia*, *Cheraw* dance, Lama dance of Sikkim, and *Rouf* dance? Find out their States of origin and the important dancers who perform these dances.

Kalbelia: Folk form of Rajasthan

Kalbelia is a community of snake charmers living in Thar Desert Region of India. *Kalbelias* are now found predominantly in the districts of Jodhpur, Jaisalmer, Jalore and Barmer in western Rajasthan and in the cities of Jaipur and Pushkar in eastern Rajasthan. The women in flowing skirts dance to the beat of the *khanjari*, a percussion instrument, and the *poongi*, a wind instrument.

Cheraw

This dance form performed in Mizoram is recognised as one of the oldest forms of folk arts. It is characterised by the use of bamboo staves which are kept in cross and horizontal forms on the ground. While the male dancers move these bamboo staves in rhythmic beats, the female dancers perform by stepping in and out of the bamboo blocks.

Lama Music and Dances of Sikkim

Lama dances are masked dances performed with beats of varied types of rhythm by the Buddhist monks of Sikkim as a part of their religious practices. The practices are codified in the religious texts of Sikkim in accordance with the teachings of Guru Padmashambhava, the legendary saint of the Mahayana school of Buddhism. Based on these, Lamas conduct prayers for the benefit of Buddhism and the state of Sikkim. Gorgeous attire and colourful masks made according to the scriptures are used with traditional musical instruments like cymbals and big horns rendering the codified religious music and chanting.

Rouf

One of the most popular traditional music and dances of Kashmir is *Rouf*. It graces all the festive occasions, especially

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Eid and *Ramzan* days. The music and dance is performed by a group of women facing each other. The song that is sung during the performance is in the form of question and answer where one group questions and the other responds to it in a rhythmic way.

Shadow Puppet Theatre Traditions of India

The communities which are distinctively associated with it are:

1. *Chamadyacha Bahulya Thakar,* Maharashtra
2. *Tolu Bommalatta Killekyata or Are Kapu,* Andhra Pradesh
3. *Togalu Gombeyatta Killekyata or Dayat,* Karnataka
4. *Tolu Bommalattam Killekyata,* Tamil Nadu
5. *Tolpava Kuthu Vellalachetti, Nair,* Kerala
6. *Ravanachhaya Bhat,* Orissa

Though these forms have distinct regional identities, languages and dialects in which they are performed, they share a common worldview, aesthetics and themes. The narratives are mainly based on the epics of *Rāmāyaṇa* and *Mahābhārata*, *Purāṇas*, local myths and tales. They communicate significant messages to the rural community besides entertainment.

Some examples of folk or living traditions of theatre

Bhavai

Bhavai is a traditional theatre form of Gujarat and Rajasthan with its deep roots in Kutch and Kathiawar in Gujarat. Bhavai originated as a prayer to the Goddess *Amba*, during the Navaratra festival.

Tamasha

Tamasha is a traditional folk theatre form of Maharashtra. The term 'Tamasha' is derived from Persian.

Bhagawatmela and Kuchipudi

Many dance drama forms in Andhra Pradesh and Tamil Nadu are prevalent which are called by different names—*Bhāgavatamela*, *Kuchipudi, Bhamakalapam, Yakṣagaṇa,* etc. Others, such as *Vīthināṭakam* of Andhra Pradesh and *Terukoothu* in Tamil Nadu are street theatre forms. Besides, there are several *Kurvanji* forms.

Bhand Pather

Bhand theatre is popular in Northern India, specially in Kashmir and Punjab. *Bhand Pather* of Kashmir, is a unique combination of dance, music and drama where satire, wit and parody are preferred for inducing laughter.

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Nautanki

As the term *Nautanki* itself suggests, the basis of this form of entertainment is *Natak* (play). *Nautanki* presentation of Kanpur, Lucknow, Hathras and a few places in Haryana are famous because of their distinctive styles. Parsi theatre also influenced this traditional theatre form. The most important role of narrator is played by the *Ranga*, who begins the story to be presented. The *Ranga* connects the various episodes of the play. The most important instruments of *Nautanki* are the *Nagaara* and *Tikaari*.

Swang

Swang is a folk-theatre form of Haryana and Punjab. It is similar to *Nautanki*, traditional theatre form of Uttar Pradesh. *Bahurupias* also practised *Swang* to earn their livelihood. On the occasion of Holi festival, *Swang* artists move around in small groups displaying their art and during Dussehra festival, they are part of various tableaux.

Rāslīlā

Based exclusively on the legendary stories of Radha and Krishna, *Rāslīlā* is a highly musical traditional theatre form of Uttar Pradesh.

Jātrā

Jatra is one of the most popular traditional theatre forms of Bengal and Orissa. They travel from one place to another to perform hence the name *Jātrā*. Over the centuries, faith and religious fervour has been replaced in this folk theatre form with contemporary themes of social and historical significance.

Kutiyattam

In Kerala, the tradition of *Kutiyattam* is easily the most prominent survivor among the forms containing some essential elements of content and structural features of Sanskrit theatre. While scholars are correct in often calling *Kutiyattam* the only surviving tradition in Sanskrit theatre, *Kutiyattam* has also incorporated local traditions, culture and themes.

Bhāgavatamela and Kuchipudi

Many dance drama forms in Andhra Pradesh and Tamil Nadu are prevalent which are called by different names—*Bhagawatmela*, *Kuchipudi*, *Bhamakalapam*, Yakshagana, etc. Others, such as *Veethinatakam* of Andhra Pradesh and *Terukoothu* in Tamil Nadu are street theatre forms.

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Exercises

1. Define performing arts. What is the role of music in performing arts?
2. Define *Sāmagāna*. How many streams of Music are there in Vedic Era?
3. Write short notes on *Nāṭyaśāshtra, Bṛhaddeshī* and *Saṅgīta Ratnākara*.
4. How many forms of Classical Music are there in India? Describe them.
5. Explain *Śruti, Rāgas, Svara, Laya, Tāla, Mātrā, Mūrchana, Jāti and Grāma*.
6. How many types of instruments are there in music? Explain them.
7. Write short notes on Pandit Vishnu Narayan Bhatkhande and Pandit Vishnu Digambar Paluskar.
8. Attend any regional theatre performance in your area and make a detailed report on style, character, customs, make-up and props.
9. Recreate any regional theatre performance with your classmates.
10. What is the role of dance in Indian music? Explain.
11. Write and explain the different forms of dances.
12. You studied about *Rouf* in Kashmir, find out other folk music and dances in Jammu and Kashmir.
13. Have you seen *Jātra, Kutiyattam* or any such tradition folk play? Narrate any one in the class.
14. Find out one folk dance and song from each State of India. Make a folder with pictures in digital or print form. What are your views and observation about the people of India? Share on NROER for enriching others.

Endnotes

1. Som Benegal, *Panorama of Theatre in India*, Popular Prakashan for ICCR, 1968
2. There are many translations of *Natyasastra* in English and Indian languages. We have referred to two translations mainly—Manomohan Ghosh's *The Natyasastra,* Calcutta, Asiatic Society, 1951, and Kapila Vatsayan's *Bharata: The Natyasastra*, Sahitya Akademi, 2003. It is recommended to go through their Introductions.
3. Malyaban Chattopadhyay, "A Historical Study of Ancient Indian Theatre-Communication in the Light of *Natyasastra*", Global Media Journal-Indian Edition, Sponsored by the University of Calcutta, December 2013, Vol. 4. No. 2
4. *Natyasastra*, Chapter Eighteen

Suggested Readings and Viewings

1. Adya Rangacharya, *Indian Theatre*, N.B.T.
2. Balwant Gargi, *Folk Theatre of India*, South Asia Books.

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3. Govind Chatak, *Rangmanch: Kala aur Drishty*, Takshshila Prakashan
4. Sitaram Chaturvedi, *Bhartiya Tatha Paschatya Rangmanch*, Hindi Samiti, Suchna Vibhag, Uttar Pradesh
5. Virendra Narayan, *Rangkarm*, Alekh Prakashan
6. Kapila Vatsyayan, *Traditional Indian Theatre*, Multiple Streams, N.B.T.

Some suggestions for exploring

7. Texts on our music tradition—*Natyashastra, Brihaddesi, Sangeet Ratnakar, Sangeet Parijat, Raag Tarangini,* etc.
8. Let's find out about the lives of our musicians—
   Tansen, Baiju Bavra, Gopal Nayak, Pandit Vishnu Narayan Bhatkhande and Pandit Vishnu Digambar Paluskar, Pandit Omkarnath Thakur, etc.
9. Listen to *Ragas* like — *Yaman, Bhairav, Bhairavi, Kafi, Bilawal, Khamaj*, etc.
10. How is the *Gharana* system important in music and dance? Explore.
11. Musical instruments are so interesting to know about—let's know them.
12. Watch these videos—
    - https://www.youtube.com/watch?v=ulIuuirC-vI (define Naad and Dhwani)
    - https://www.youtube.com/watch?v=UYT-IHNg9AM (Zakir Husain | Birju Maharaj performance)
    - https://www.youtube.com/watch?v=skkSuyQHsus (online project activity in Music)
    - https://www.youtube.com/watch?v=Hqpxk4QG1RQ (chal mere dhol- audio story from Kumaun lok katha)
13. https://nroer.gov.in/55ab34ff81fccb4f1d806025/page/5b5968e616b51c01f04a2b42 (KATHAK- Origin and development and activity)\
14. https://nroer.gov.in/55ab34ff81fccb4f1d806025/page/58738c54472d4a7117b13ff8 (bharat natyam video)
15. https://nroer.gov.in/55ab34ff81fccb4f1d806025/page/58e4808f472d4aca81adce6d (This video is a documentation of Gurkul traditions of Kathakali in Kerala.)
16. https://nroer.gov.in/55ab34ff81fccb4f1d806025/page/5874700c472d4a6b7076eacf (The video was recorded during the National Role Play and Folk Dance Competition in 2012.)
17. https://www.youtube.com/watch?v=2ORe29IRGQU (odissi dance video from ncert youtube chennal)
18. https://www.youtube.com/watch?v=P6f0MinVE_E (mohiniattam dance video)
19. https://www.youtube.com/watch?v=q9AT8l9NttU (folk dance video)
20. https://www.youtube.com/watch?v=rw2zmaV0xOU (kathakali dance video)

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21. https://www.youtube.com/watch?v=Tvx8zmV4HJo (kathak dance video)
22. https://www.youtube.com/watch?v=KyFVrJK0WEM (Manipuri dance video)
23. https://www.youtube.com/watch?v=TJb26K2X104 (kathakali dance video)
24. https://www.youtube.com/watch?v=eWJdP_TTrfw (mohiniattam dance video)
25. https://www.youtube.com/watch?v=shsZ7JpNAUo (raas leela dance video)
26. https://www.indianetzone.com/1/tamasha.htm – (Tamasha folk art form)
27. http://www.indiaprofile.com/religion-culture/jatras.htm (Jatra Theatre form)
28. https://ich.unesco.org/en/RL/kutiyattam-sanskrit-theatre-00010 (Kutiyattam)

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Indian Art and Architecture

4

Introduction

This chapter on Indian art and architecture will take you to the journey of one of the world's oldest and richest civilisations prevalent since the earliest times when human beings were engaged with their creative pursuits for one reason or the other. This is a journey of thousands of years of tangible and intangible heritage of the Indian sub-continent starting from the cave habitats to the oral tradition of *Vedas* to the writing of *Shastras* — the text on all possible topics where the wisdom of our ancestors has poured in! Through this chapter, you will have glimpses of different traditions of painting, sculpture and architecture — how these evolved over the years. Some of the traditional knowledge has remained with the people, communities and is still being practised specially in the pockets of modern India. Some of these timeless traditions are the oral traditions, iron smiths, potters, weavers, painting on walls, floors and ceilings, bronze cast, etc. which you can even find being practised in your region.

Textual Sources as Repository of Traditional Knowledge

Early literary texts such as the epics of *Rāmāyaṇa* and *Mahābhārata*, Kalidasa's *Abhijñānaśākuntalam*, *Daśakumāracaritam* and later on Vātsyāyana's *Kāmasūtra* etc., refer to art galleries or *citraśālās* in the palaces. The texts on art and architecture known as *śilpaśāstra* deal with the paintings on different surfaces and media. The most comprehensive text of *Viṣṇudharmottara Purāṇa*, deals with

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the interdependence of dance, music and the visual arts. It is one of the eighteen *Upa-purāṇas* where chapters are dedicated to the methods and ideals of painting. These texts have helped in passing the traditional knowledge of basics of painting techniques and their appreciation and aesthetics from one generation to the other and one region to another. They also facilitated the ancient artists to transform the technique of murals from using rough and untreated cave walls as painting surfaces to treating them for fresco, before using them to paint.

Vāstuvidyā or *śilpaśāstra* or the science of architecture is one of the technical subjects studied in ancient India. In the earliest texts, the word *vastu* is used for building which included temple construction, town planning, public and private buildings, and later on forts.

Atharvaveda too has references to different parts of a building. Kautilya's *Arthaśāstra* deals with town planning, fortifications and other civil structures. *Samarāṅgaṇasūtradhāra*, authored by King Bhoja (1010–55 C.E.), discusses the methods of examination of a site, analysis of the soil, systems of measurement, qualifications of the *sthapati* (architect) and his assistants, building materials, consecration of the plan followed by the construction of foundation, basal mouldings and technical details for each part of the plan, design and elevation. *Mayamata* (1000 C.E.) and *Mānasāra* (1300 C.E.), are the two texts having common understanding of the architectural plans and design of the southern style of temple architecture known as *drāviḍa*.

Vātsyāyana in his *Kāmasūtra*, (second century C.E.) describes the *ṣaḍaṅga* or six limbs or elements of painting as:

1. *Rūpabheda* or the perception of difference in appearance;
2. *Pramāṇa* or valid perception, measure and form;
3. *Bhāva* or feelings expressed in forms;
4. *Lāvaṇya yojana* or infusion of grace in artistic representation;
5. *Sādṛśyam* or similarities;
6. *Vaṃikabhaṅga* or identification and analysis of colour and hue.

Painting Traditions

Tradition of painting or *Citrakalā* is one of the earliest and most common of all expressions by humans which evolved over the centuries. Any painting activity requires a surface which could be anything—a wall, floor, ceiling, leaf, human or animal body, paper, canvas, etc. Crude walls of caves or rock shelters, to the most sophisticated digital paintings today,

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the evolution of painting has made a long journey.

Hunting Scene, Prehistoric Painting, Bhimbetka

Earliest Paintings in Rock Shelters

A large number of sites, where remnants of rock paintings in the Indian sub-continent have been found on the walls of the caves situated in Madhya Pradesh, Uttar Pradesh, Andhra Pradesh, Karnataka, Uttarakhand and Bihar. The richest paintings are almost 10,000 years old as reported from the Vindhya ranges of Madhya Pradesh and their Kaimurean extensions into Uttar Pradesh. These hill ranges are full of Paleolithic and Mesolithic remains of paintings depicting human and animal figures and geometric patterns in white, black and red ochre. Humans are represented in stick figures. Wavy lines, rectangle-filled geometric designs, and groups of dots can also be seen. One of the interesting scenes commonly depicted is of hand-linked dancing human figures. It is interesting to note that at many rock-art sites, often a new painting is painted on the top of an older painting. At Bhimbetka, in some places, there are as many as 20 layers of paintings, one on top of another.

The granite rocks of Karnataka and Andhra Pradesh provided suitable canvases to the Neolithic humans for painting. The themes of paintings are of great variety, ranging from mundane events of daily life in those times to hunting and dancing, music, horse and elephant riders, animal fighting, honey collection, decoration of bodies, and other household scenes.

Bhimbetka located forty-five kilometres south of Bhopal, is a very important example of rock paintings which was declared a UNESCO World Heritage Site in 2003. The colours used here are mostly of mineral origin and have survived because the paintings were on the inner walls of the caves.

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Mural Paintings, Fifth–Sixth Century C.E., Ajanta caves

Mural Paintings, Fifth–Sixth Century C.E., Ajanta caves

Mural Painting, Ninth Century C.E., Sittanvasal

What are the criteria to declare the World Heritage sites according to the UNESCO? Find out the details at the website: https://whc.unesco.org/en/criteria/ and prepare a list of such sites in India. You will find that many of them have been discussed in this Chapter.

Mural Painting Tradition

The story of Indian mural painting starts around second century B.C.E. spread over several locations around India, the best known being Ajanta and Ellora in Maharashtra, Bagh in Madhya Pradesh and Panamalai and Sittanavasal in Tamil Nadu. The Ajanta caves consist of some of the finest surviving examples of Indian art with depictions of the Buddha and the *Jātaka* tales.

Ajanta, located in Aurangabad District of Maharashtra has twenty-nine *caitya* and *vihāra* caves decorated with sculptures and paintings from the first century B.C.E. to the fifth century C.E. Outward projections of the figures, clearly defined and rhythmic lines are used in the Ajanta paintings. Body colour gets merged with the outer line creating the effect of volume. The figures are heavy like the sculptures of western India. Some of the well known paintings of Ajanta are *Padmapāṇi Bodhisttva, Vajrapāṇi Bodhisattva, Mahājanaka Jātaka, Umaga Jātaka*, etc.

The Bagh Caves, consisting of Buddhist mural paintings, are located 97 km from Dhar district of Madhya Pradesh. These rock-cut cave monuments are not natural but were carved over a period of time during the Satvahana period. The Bagh caves, like those at Ajanta, were excavated on a perpendicular sandstone rock face of a hill across the seasonal stream of Baghani. Out of the original nine caves, only five have survived, all of which are *viharas* or resting places for monks, having a quadrangular plan.

Paintings at Vishnu cave in Badami, in Karnataka, excavated in sixth century C.E., have fragments of painting on the vaulted roof of the front *maṇḍapa*, and in this cave, paintings depict palace scenes. Stylistically the painting represents an extension of the tradition of mural painting from Ajanta to Badami in South India.

Murals under the Pallava, Pandya and Chola Kings

The tradition of painting extended further down South in Tamil Nadu in the preceding centuries with regional variations during the regimes of Pallava, Pandya and Chola dynasties, not only in caves but on the walls of temples and palaces too.

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In Panamalai, a small shrine has a small section of a mural painting of an exquisite female figure, her leg bent, standing against a wall with an umbrella above her. The Kailasanatha temple at Kanchipuram contains nearly fifty cells around the inner courtyard, with traces of paintings in red, yellow, green, and black vegetable colours. Sittanavasal in Pudukottai district is the location of a Jain monastery of the seventh century. Its walls and ceiling have been painted with mineral colours in the fresco-secco technique.

Mural Painting, Eleventh Century C.E., Thanjavur

Murals in Tirumalaipuram caves and Jain caves at Sittanavasal are some of the surviving examples under Pandyas, where the paintings are visible on the ceilings of shrines, in verandas, and on the brackets. On the pillars of the veranda are seen dancing figures of celestial nymphs.

The tradition of building temples and embellishing them with carvings and paintings continued during the reign of the Chola kings between ninth to thirteenth century. But it was in the eleventh century, when the Cholas reached their zenith of power, when masterpieces of the Chola art and architecture began to appear. Though Chola paintings are seen in Narthamalai, the most important are those in Brihadeswara temple.

The paintings were executed on the walls of the narrow passage surrounding the shrine. Two layers of paintings were found when they were discovered. The upper layers were painted during the *Nāyaka* period, in the sixteenth century. The paintings show the narrations and aspects related to Lord Shiva on Kailash, Shiva as *Tripurāntaka*, Shiva as *Naṭarāja*, a portrait of the patron Rajaraja and his mentor Kuruvar, dancing figures, etc. The walls on either side of the narrow and dark passage of the inner *vimāna*, above the *sanctum sanctorum*, were painted later on.

Even today, we observe that mural paintings on interior and exterior walls of houses in villages or *havelis* are prevalent in different parts of the country. These paintings are usually made by women either at the time of ceremonies or festivals or as a routine to clean and decorate the wall and the floor. Some of the traditional forms of murals are Pithoro in parts of Madhya Pradesh, Rajasthan and Gujarat, Mithila painting in northern Bihar's Mithila region, Warli paintings in Maharashtra, or simply paintings on the walls, be it in a village of Odisha or Bengal, Madhya Pradesh or Chhattisgarh.

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Palm Leaf Manuscript Painting

The Buddhist manuscript paintings of Pala period, earliest being the *Aṣṭā Sāhasrikā Prajñāpāramitā,* were drawn in red and white, forming colour planes. The inspiration came from the metal images, giving an illusion of relief. Miniatures were painted according to the rules of mural painting, the rule of proportions being regulated by strict codes of measurement. Effects such as foreshortening were derived from the study of sculpture rather than from reality. The human figure was represented in the simplest and most visible manner. Against a background of rich colour, stood out thick, boldly drawn figures. The paintings were harmonised with the enclosing script. The Jain painters from western India preferred three-quarter profiles, displacing one of the eyes to avoid foreshortening, while frontal images had eyes set near the bridge of the nose.

Palm leaf Manuscript Painting

Dancing Girl, Indus Valley Civilisation
Source: CCRT

Indus Valley and the Phenomenon of Town Planning

You have already read about the Indus Valley Civilisation in earlier classes which is one of the earliest civilisations existed during the second half of the third millennium B.C.E. In present days, there are sites of this civilisation having an expanse in Harappa and Mohenjodaro in Pakistan and in India, Lothal and Dholavira in Gujarat, Rakhigarhi in Haryana, Ropar in Punjab, Kalibangan and Balathal in Rajasthan. This civilisation has the unique example of well laid out town planning, artefacts such as sculptures in various materials, seals, pottery, jewellery, terracotta figures, etc. The use of metal casting techniques prevalent in those days is not very different from the contemporary practices. One of the earliest examples of civic planning with houses, markets, storage facilities, offices, public baths, burial ground, etc., were arranged in a grid-like pattern. There was also a highly developed drainage system.

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Cities were planned, with the streets generally oriented along the cardinal directions, in some cases had an upper storey, also bricks of standardised proportions were used for buildings with roofs of wood. Most houses had individual bathrooms connected to extensive drainage networks. Complex structures, such as Mohenjodaro's public bath or the granary, had great skills of advanced planning and construction.

At Dholavira, a large and rigorously planned city located on an island in the Rann of Kutch, stone was used to build massive fortifications, while a network of enormous reservoirs ensured water supply to the city through the year.

Sculptures in stone, are excellent examples of handling three-dimensional volumes. The male figure, a torso in red sandstone polished, chiselled in round, is remarkable for its naturalistic pose and sophisticated modelling, highlighting its physical beauty. Another bust of a bearded man in steatite had its head and arms carved separately and socketed into the drilled holes of the torso. Another noteworthy example, is the bust of a bearded man, from Mohenjodaro, wearing a shawl with trefoil pattern.

The art of bronze-casting was practised on a wide scale using the 'lost wax' technique for making sculptures. In bronze we find human as well as animal figures, the best example of the former being the statue of a girl popularly titled 'Dancing Girl'. Found in Mohenjodaro, this exquisite casting depicts a girl whose long hair is tied in a bun. Bangles cover her left arm, a bracelet and an amulet or bangle adorn her right arm, and a cowrie shell necklace is seen around her neck. Her right hand is on her hip and her left hand is clasped in a dance gesture. She has large eyes and flat nose. Among animal figures in bronze, the buffalo with its uplifted head, back and sweeping horns and the goat are of artistic merit.

> Bronze is an alloy made with different metals: the people of the sub-continent knew about the metals and how to make alloy. Later on we get a lot of literature on metallurgy documenting techniques of making metals and alloys. Find out more about it.

Terracotta images were crude as compared to the stone and bronze statues. A large number of seals made of steatite, terracotta and copper of various shapes and sizes have also been discovered. Generally they are rectangular, some are circular and few are cylindrical. Almost invariably they bear on them the representation of a human or an animal figure and have on top an inscription in pictographic script which

Bust of a bearded priest, Indus Valley Civilisation

Source: CCRT

Terracotta Indus Valley site

Seal Unicorn, Indus Valley site

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Sānchi Stūpa, Second Century B.C.E., Sanchi

has not been deciphered so far. A seated figure surrounded by four animals—a rhino, a buffalo, an elephant and a tiger is unique.

There are two deer shown under the throne. Most of these seals have a knob at the back through which runs a hole and it is believed that they were used by different guilds or merchants and traders for stamping purposes.

Mauryan Art

The Mauryas established their power by the third century B.C.E. and soon a large part of India was under Mauryan control. Pillars, sculptures and rock-cut architecture, *stūpas* and *vihāras*, rock-cut caves and monumental figure sculptures were carved at several places belonging to this period. Ashoka got erected many monolithic pillars of sandstone, 30 to 40 feet high, crowned by animal figures like the bull, lion and elephant, inscribed with the ideas of morality, humanity and piety, which he wished his people to follow. Ashoka started making extensive use of stone for sculptures and great monuments whereas the previous tradition consisted of working with wood and clay. Famous Ashokan pillars are from Lauriya Nandangarh in Bihar, Sanchi and Sarnath. Excellent specimens of the Mauryan craftsmanship in fashioning the human figure are provided by the colossal statues of *Yakśa* and *Yakśī*, found from Patna, Vidisha and Mathura.

Lion Capital, Third Century B.C.E., Sanchi

Lion Capital, Mauryan Period, Rampurva

Yakshini, Mauryan Period, Bidarganj
Source: CCRT

> The Indian National emblem of four lions seated in four directions, is representative of the highly polished monolithic lion-capital of Sarnath.

In architectural remains of this period, the gradual transition from wood to stone is apparent. However, wood was still the dominant material. A typical example of this is the Lomas Rishi cave in the Barabar Hills of Bihar.

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Stūpa is another form of architecture constructed during this time. Stūpa worship was an ancient form of honouring the great dead. Stūpas were built not only to enshrine the relics of Buddha and Buddhist saints, but also to commemorate the events of religious significance. The outstanding example of an early Buddhist stūpa built during the third and first century B.C.E. is at Sanchi. The present Stūpa at Sanchi was originally constructed during Ashoka's reign but was considerably enlarged with circumambulatory enclosure as well as the outer enclosures were added in the first century B.C.E. Bharhut, Sanchi and Bodh Gaya are the most famous in the North and Amravati and Nagarjunakonda in the South.

Lomas Rishi cave

Post-Mauryan Trends in Indian Art and Architecture

From the second century B.C.E. onward, various rulers established their control over the sub-continent: the Shungas, Kanvas, Kushanas and Guptas in the North and parts of central India; the Satvahanas, Ikshavakus, Abhiras, Vakataks in southern and western India. Incidentally, the period of the second century B.C.E. also marked the rise of the main Brahmanical sects such as the Vaishnavas and the Shaivas. Some of the prominent examples of the finest sculptures are found at Vidisha and Bharhut (Madhya Pradesh), Bodhgaya (Bihar), Jaggayyapeta (Andhra Pradesh), Mathura (Uttar Pradesh), Khandagiri-Udaigiri (Odisha), Bhaja and Pavani (Maharashtra).

Bharhut sculptures are tall like the images of Yakśa and Yakśiṇī of Mauryan period, modelling of the sculptural volume is in low relief maintaining linearity. Images stick to the picture plane. In the relief panels depicting narratives, illusion of three-dimensionality is shown with tilted perspective. Clarity in the narrative is enhanced by selecting the main events.

Mathura, Gandhara and Sarnath schools are predominantly Buddhist. Images of Buddha in Gandhara and Mathura was a parallel development, where it was produced

Gate (Details), Fifth century C.E., Sanchi

Queen Maya's dream, Bharhut

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Meditating Buddha, Third–fourth century C.E., Gandhar

Seated Buddha, Katra Mound, Mathura

Seated Buddha, Sarnath

by the local artist craftsmen working in the local tradition. At Mathura, it clearly emerges from the Yaksha tradition.

The Buddhist religion flourished under the patronage of Kushan emperors, and several images of the Buddha and Bodhisattavas were produced after the earlier Yakśa types. A typical example of the image of Buddha, from second century C.E., shows him seated cross-legged on a lion-throne, under the Bodhi tree, with his right hand in the gesture of assuring protection, while the left is placed on the thigh. The eyes are wide open and the protuberance on the skull is indicated by a single curl coiled to the left. The hands and feet are marked with auspicious symbols. Two flying figures standing on either side, are shown above. This type of image of the Buddha reached perfection in the Gupta age, three centuries later.

You can visit museums at Mathura, Sarnath, Allahabad, Varanasi, National Museum in New Delhi, Chennai, Amaravati, or the site museums, etc., to study the features of early sculptures.

Images of Vaishnava and Shaiva traditions are also found at Mathura. It may be noted that the images of Vishnu and Shiva are represented with their *āyudhas* (weapons). There is boldness in carving the large images, the volume of the images is projected out of the picture plane, the faces are round and smiling, and the heaviness in the sculptural volume is reduced to relaxed flesh. The garments of the body are clearly visible and they cover the left shoulder. In

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the second century C.E., images in Mathura get sensual, they depict lesser garments. In the third century C.E., the treatment of sculptural volume changes by making them thinner, movement in the posture is shown by increasing distance between the two legs as well as by using bends in the body posture. Softness in the surface continues to get refined. The trend continues in the fourth century C.E. but in the late fourth century C.E., the massiveness is reduced further. The volume of the drapery also gets reduced and in the fifth and sixth century C.E., the drapery is integrated into the sculptural mass. Transparent quality in the robes of the Buddha images is evident. In this period, important schools of sculptures in northern India worth noting are Mathura, Sarnath and Kosambi. Many Buddha images in Sarnath have plain transparent drapery covering both shoulders, and the halo around the head has very little ornamentation whereas the Mathura Buddha images continue to depict folds of the drapery in the Buddha images and the halo around the head is profusely decorated.

Chola Bronze, Tamil Nadu

Indian Bronze Sculptures

Indian sculptors had mastered the bronze medium, an alloy of metals by mixing copper, zinc and tin with cire-perdue or lost-wax casting process as much as they had mastered terracotta sculpture and carving in stone as earlier as the Indus Valley Culture. Bronze sculptures of Buddhist, Hindu and Jain icons have been discovered from many regions of India dating from the second century until the sixteenth century. Most of these were required for ritual worship and are characterised by exquisite beauty and aesthetic appeal. At the same time, the metal-casting process continued to be utilised for making articles for various purposes of daily use, such as utensils for cooking, eating, drinking, etc.

Nāṭarāja, Chola period

> Present-day tribal communities also use the 'lost-wax' process for their art expressions.

Interesting images of Jain Tirthankaras have been discovered from Chausa, Bihar, belonging to the Kushana Period during second century C.E. These bronzes show how the Indian sculptors had mastered the

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modelling of masculine human physique and simplified it. Many standing Buddha images with right hand in *abhaya mudrā* were cast in North India, particularly Uttar Pradesh and Bihar, during the Gupta and post-Gupta period, i.e., between the fifth and seventh century. Vakataka bronze images of the Buddha from Phophnar, Maharashtra, are contemporary with the Gupta period bronzes statues. They show the influence of the Amaravati style of sculptures of the third century C.E. and at the same time there is a significant change in the draping style of the monk's robe.

The additional importance of the Gupta and Vakataka bronzes is that they were portable, and monks carried them from place to place for the purpose of individual worship or to be installed in Buddhist *vihāras*. In this manner, the refined classical style spread to different parts of India and to other Asian countries as well. The hoard of bronzes discovered in Akota near Vadodara established that bronze casting was practised in Gujarat also.

Himachal Pradesh and Kashmir regions also produced bronze images of Buddhist deities as well as Hindu gods and goddesses. Most of these were created during the eighth, ninth and tenth centuries and have a very distinct style in comparison with bronzes from other parts of India. A noteworthy development is the growth of different types of iconography of Vishnu images.

In Buddhist centres like Nalanda, a school of bronze-casting emerged around the ninth century during the rule of the Pala Dynasty in Bihar and Bengal regions. In the gap of a few centuries, the sculptors at Kurkihar near Nalanda were able to revive the classical style of the Gupta period.

Unfinished Chaitya cave, Kanheri

Although bronze images were modelled and cast during the Pallava Period in the eighth and ninth centuries, some of the most beautiful and exquisite statues were produced during the Chola Period in Tamil Nadu from the tenth to the twelfth century. The technique and art of fashioning bronze images is still skillfully practised in South India, particularly in Kumbakonam.

In the Pallava Period, bronzes of the eighth century is the icon of Shiva seated in *ardhaparyaṅka āsana* (one leg kept dangling). The right hand is in the *ācamana*

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mudrā gesture, suggesting that he is about to drink poison. The well-known dancing figure of Shiva as *Nāṭarāja* was evolved and fully developed during the Chola period and since then many variations of this complex bronze image have been modelled. A wide range of Shiva iconography was evolved in the Thanjavur (Tanjore) region of Tamil Nadu.

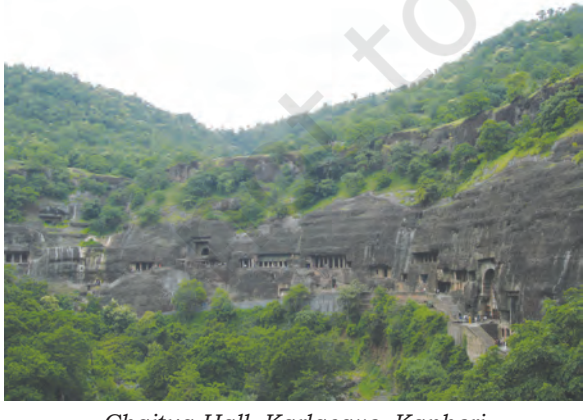
Chaitya Hall, Karla caves, Kanheri

Buddhist Monuments of Deccan, East and South India

In today's Andhra Pradesh and Telangana there are many stūpa sites like Jagayyapetta, Amaravati, Bhattiprolu, Nagarjūnkonda, Goli, etc. Amaravati has a *mahācaitya* and had many sculptures which are now preserved in Chennai Museum, Amaravati Site Museum, National Museum, New Delhi and the British Museum, London.

In western India, many Buddhist caves dating back to the second century B.C.E. onward have been excavated. These include Bhaja, Kanheri, Karla, Ajanta, Ellora, Bedasa, Nashik, Junnar, Pitalkhora, etc. The front of the *caitya* hall is dominated by the motif of a semi-circular *caitya* arch with an open front which has a wooden facade and, in some cases, there is no dominating *caitya* arch window. In all the *caitya* caves, a stūpa at the back is common.

Located in Aurangabad District of Maharashtra, Ajanta has twenty-nine caves, built over a period of almost eight centuries. We have already read about the paintings of Ajanta caves in this chapter. Cave number 26 is very big and the entire interior hall is carved with a variety of Buddha images, the biggest one being the *Mahāparinibbāṇa* image. The rest of the caves are *vihāra-caitya* caves. They consist of a pillared veranda, a pillared hall and cells along the walls.



Chaitya Hall, Karlacave, Kanheri

Kailashanath Temple, Eleventh Century C.E., Ellora

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Udayagiri and Khandagiri caves near Bhubaneswar

The back wall has the main Buddha shrine. Shrine images at Ajanta are grand in size.

Almost 100 kilometres from Ajanta, another important cave site is Ellora, and has 32 Buddhist, Brahmanical and Jain caves. It is a unique art-historical site in the country as it has monasteries associated with the three religions dating from the fifth century C.E. onward to the eleventh century C.E. It is also unique in terms of stylistic eclecticism, i.e., confluence of many styles at one place.

The tradition of rock-cut caves continued in the Deccan and they are found not only in Maharashtra but also in Karnataka, mainly at Badami and Aiholi, executed under the patronage of the Chalukyas, in Andhra Pradesh and Tamil Nadu.

Like in western India, Buddhist caves were also excavated in eastern India, mainly in the coastal regions, present day of Andhra Pradesh, and Odisha. One of the main sites in Andhra Pradesh is Guntapalle in Eluru district. The caves have been excavated in the hills along with the structured monasteries. Perhaps it is among the very unique sites where the structured stūpas, *vihāras* and the caves are excavated at one place. The Guntapalle *caitya* cave is circular with a stūpa in the circular hall and a *caitya* arch carved at the entrance.

The earliest examples of rock-cut cave tradition in Odisha are the Udayagiri and Khandagiri caves in the vicinity of Bhubaneswar. These caves are scattered and have inscriptions of Kharavela king. According to the inscriptions, the caves were meant for Jain monks. There are numerous single-cell excavations. Some have been carved in huge independent boulders and given the shape of animals. The big caves include a cave with a pillared veranda with cells at the back.

Development of Temple Architecture in India

Early Temple Architecture

Some of the important sites of early temples in North India are Deogarh in Uttar Pradesh, Eran, Nachna-Kuthara and Udayagiri near Vidisha in Madhya Pradesh. These temples are simple structures consisting of a veranda, a hall and a

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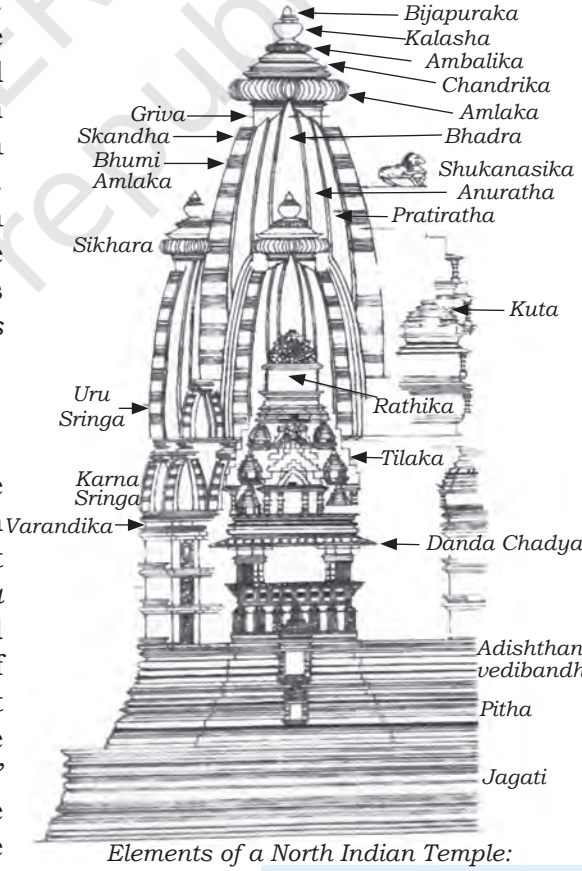
Daśāvatara Vishnu temple, Fifth century C.E., Deogarh

Ratha style of temples, Mahabalipuram

shrine at the rear. The Brahmanical cave numbers 13–28 have many sculptures. Many caves are dedicated to Shaivism, but the images of both Shiva and Vishnu and their various forms according to Puranic narrative are depicted. The sculptures at Ellora are monumental, and have protruding volume that create deep recession in the picture space. The images are heavy and show considerable sophistication in the handling of sculptural volume. Various guilds at Ellora came from different places like Vidarbha, Karnataka and Tamil Nadu and carved the sculptures. Thereby it is the most diverse site in India in terms of the sculptural styles. One of the early examples of *Ratha* style of temples is at Mahabalipuram where the five *Rathas* represent the five Pandavas.

Nagara Style of Indian Temple

In North India, it is common for an entire temple to be built on a stone platform with steps leading up to it. While the earliest temples had just one *śikhara* with *garbhagṛha* located directly under it, later temples had several *śikhara*. There are several types of *śikhara*, the simple one having a square at the base and whose walls curve or slope inward to a point on top is called the 'latina' or the *rekhā-prāsāda* type of *śikhara*. The second major type of *nagara* temple is the *phamsana*. *Phamsana* buildings tend to be



Elements of a North Indian Temple: Plan of Nagara temple

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Vishvanatha temple, Khajuraho
Source: CCRT

broader and shorter than latina ones. Their roofs are composed of several slabs that gently rise to a single point over the centre of the building, unlike the latina ones which look like sharply rising tall towers. *Phamsana* roofs do not curve inward, instead they slope upwards on a straight incline. Later on, the latina type of temples grew complex, and instead of appearing like a single tall *śikhara*, the temple began to support many smaller towers, with the tallest one being in the centre. The third main sub-type of the *nagara* temple is what is generally rectangular and called the *valabhi* type with a roof that rises into a vaulted chamber.

Ancient temples of Uttar Pradesh, Madhya Pradesh and Rajasthan share many traits. The most visible is that they are made of sandstone. Some of the oldest surviving structural temples from the Gupta Period are in Madhya Pradesh. These are relatively modest-looking shrines each having four pillars that support a small *maṇḍapa* which looks like a simple square porch-like extension before an equally small room that served as the *garbhagṛha*. Importantly, of the two such temples that survive, one is at Udayagiri, which is on the outskirts of Vidisha, while the other one is at Sanchi, both being Buddhist sites.

The temples in the north-western parts of India including Gujarat and Rajasthan, and stylistically extendable, at times, to western Madhya Pradesh are too many to include here in a comprehensive way. The stone used to build the temples ranges in colour and type. While sandstone is the commonest, a grey to black basalt can be seen in some of the tenth to twelfth century temple sculptures. The most exuberant and

Sun temple, Modhera, Gujarat

Jain temple, Eleventh – Thirteenth Century, Rajasthan

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famed is the soft white marble which is also seen in some of the tenth to twelfth century Jain temples in Mount Abu and the fifteenth century temples at Ranakpur.

The main architectural features of Odisha temples are classified in three orders, i.e., *rekhāpīḍa*, *pidhadeula* and *khākarā*. Most of the main temple sites are located in ancient Kalinga—modern Puri District, including Bhubaneswar or ancient Tribhuvanesvara, Puri and Konark.

Jain temple, Eleventh – Thirteenth Century, Rajasthan

Drāviḍa Temple Style

Unlike the *nagara* temple, the *Drāviḍa* temple is enclosed within a compound wall. The front wall has an entrance gateway in its centre, known as *gopuram*. The shape of the main temple tower known as Vimāna is similar to a stepped pyramid that rises up geometrically rather than the curving *śikhara* of north India.

It was in the eleventh century, when the Cholas reached their zenith of power, that masterpieces of Chola art and architecture began to appear with temples of Brihadeswara at Thanjavur, Gangaikonda Cholapuram and Darasuram.

A noteworthy aspect of these migrations and conquests was that Muslim rulers absorbed many features of local cultures and traditions and combined them with their own architectural practices. Thus, in the field of architecture, a mix of many structural techniques, stylised shapes, and surface decorations came about through constant interventions of acceptance, rejection or modification of architectural elements. These architectural entities or categories showcasing multiple styles are known as Indo-Saracenic or Indo-Islamic architecture.

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Exercises

1. Prepare a timeline on the map of India, either with the help of a free and open software or on a chart paper, showing important places or sites of the Indian art from the beginning up to tenth century C.E.
2. Explore any historical archaeological site, monument or museum in your neighbouring area and describe it with illustrations, photographs, sketches, etc.
3. Teacher or facilitator can identify an ancient text on art or architecture and discuss with students about when it was written, its relevence, the content, etc.

Suggested Readings

1. *Ancient India*, V.D. Mahajan, S. Chand
2. *Art and Archaeology of Ancient India: Earliest Times to the Sixth Century*, Naman P. Ahuja, Ashmolean Museum
3. *Indian Sculpture*, Grace Morley
4. *Elements of Indian Art*, S.P. Gupta,
5. *Indian Art*, Partha Mitter, Oxford History of Art

Useful links

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Bibliography

An Introduction to Indian Art-Part I, Textbook for Visual Arts for Class XI, NCERT

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Astronomy in India

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Astronomy is the study of objects seen in the sky. It is an ancient science, dating back perhaps to the time when humans came out of caves to live in the open. They must have felt a sense of wonder and awe as they looked at the sky and observed celestial phenomena like the phases of the moon, eclipses and appearance of different stars in the sky. In the absence of real understanding, humans wove these phenomena in mystery and incorporated them in their myths and religions.

India, being a very old civilisation, had a strong tradition of astronomy. *Vedas* and other religious texts speculated upon many important questions of astronomy and cosmology. These included questions relating to the origin of the universe, though the discussion was couched in philosophical terms. At the same time, there was a lot of activity in practical astronomy which people needed in their daily lives. For example, people needed to know when rains would come, and they could sow their crops. They also needed to know when they could celebrate marriages, and other ceremonies and festivals. Besides, phenomena like the eclipses and appearance of comets and shooting stars in the sky were believed to bring misfortune to rulers and destruction from wars, natural disasters like floods and earthquakes. Many kings had, in fact, appointed astronomers to keep an eye on the sky and report to them the occurrence of any such astronomical events. Moreover, most people believed in astrology which held that the motion of heavenly bodies and the occurrence of natural phenomena had a profound

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influence on their destiny. So, it was necessary to follow the motion of heavenly bodies and to track events like eclipses.

Thus, the main preoccupations of the ancient astronomers were—(i) devising calendars and reliable time-keeping devices for measuring time, (ii) predicting time of occurrence and duration of astronomical events such as eclipses, (iii) noting the time of appearance of certain stars in the sky, and (iv) observing the sun, moon and planets.

It is important to note that all these activities required reliable estimates of the distances of the sun, moon and other astronomical objects, as well as the ability to undertake tedious mathematical calculations. Many important contributions were made in these fields for which due credit has perhaps not been given to Indian astronomers by the Western historians of science.

The following section discuss the development of Indian calendar. We will also discuss the phenomena of eclipses and the variation in duration of sunlight in a day over the period of a year. We will chronologically discuss India's contribution in the field of astronomy.

Astronomical Practices in India

Let us consider first, the development of the Indian calendar, often referred to as Hindu calendar, because other communities have their own calendars. The Hindu calendar is used by the majority of Indians, even when there is freedom to use the official Western calendar, which is much simpler to use. In contrast, most other calendars are based either on the movement of the moon alone (lunar calendars), or the movement of the sun alone (solar calendars). The lunar month in the luni-solar Hindu calendar is used for fixing the dates of festivals and other auspicious days, while the solar month is used for regulating day-to-day life of the people. Since the dates of festivals, days for fasting and special worships, are all decided by the phases of the moon, the moon seems to govern much of our social life.

The orbital period of the moon with respect to the stars, called the sidereal period, is 27.3 days. The orbital period observed from the moving earth round the Sun is 29.5 days. Therefore, the lunar month consists of two halves of 15 days each, the dark half (*Kṛṣṇapakṣa* कृष्णपक्ष) starting with the full moon as day one (*ekam* प्रथमा or एकम्), and the bright half (*Śuklapakṣa* शुक्लपक्ष) starting with the new moon day as day one *(ekam*). However, in some calendars, the new moon day is taken as the last day of *Kṛṣṇapakṣa* and the full moon day is taken as the last day of the *Śuklapakṣa*. So, while stating the day of the month, we have to specify

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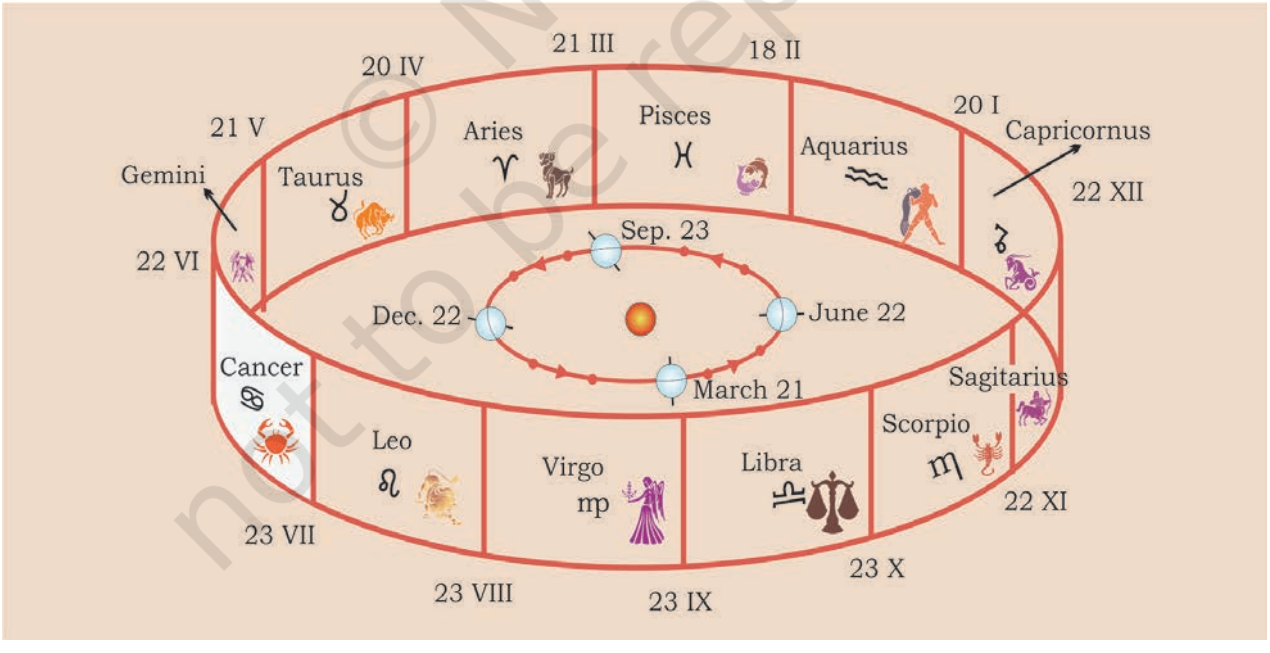
whether it falls in the *Kṛṣṇapakṣa* or *Śuklapakṣa*. There is no uniform practice regarding the start of the month; in some regions the month starts on a new moon day, while in other regions the start of the month is reckoned from the full moon day.

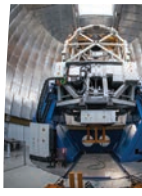
To understand the solar month, we would need to understand the concept of stellar constellations. A constellation is a group of stars that resembles the figure of an animal, a figure from a mythical story, or an imaginary object. The point is that each constellation is a familiar figure in the night sky which can be easily identified.

The path of the earth round the Sun is called ecliptic. On both sides of the ecliptic, a belt around 8 degrees wide has been defined as Zodiac, or *Rāśi Cakra*. *Rāśi Cakra* contains 12 constellations. These are known as zodiacal constellations, or *Rāśis*. These constellations and their signs are shown in the figure below. During its annual motion, the Sun takes about a month to cross each constellation.

Another important component of the Indian calendar is *Nakṣatra*. To understand what a *Nakṣatra* is, consider the motion of the moon round the earth. With respect to stars, the orbital period of the moon is 27.3 days. With each day of the lunar orbit, ancient astronomers identified a prominent star and associated it with the moon. These stars are called *Nakṣatras*. In all there are 27 or 28 *Nakṣatras*. The position of the moon is, thus, defined in terms of *Nakṣatras*.



The constellations of the zodiac. As seen from the earth, in early March the Sun is in Pisces. (I,II, ... in the diagram refers to months January, February, ... respectively while numbers before them refer to dates)



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The Sun takes roughly 30 days to move through a *Rāśi*. The day the Sun enters a *Rāśi* is called *Saṅkrānti* (मकर संक्रांति). For example, *Makarā Saṅkrānti* (मकर संक्रांति) is the day when the Sun enters *Makarā Rāśi* (मकर राशि, Capricornus). The length of a solar month in Indian calendar is reckoned from one *Saṅkrānti* to the next. The month is named after the *Nakshatra* seen on the full moon day in that month. For example, the month *Caitra* is named after the *Nakśatra Citrā*. The day in Hindu calendar is defined from one sunrise to the next sunrise. In contrast, the day in Western calendar begins at midnight. As the speed of the Sun in its orbit is not uniform and the sizes of zodiacal constellations are unequal, the length of a solar month in Hindu calendar is also unequal; it can vary from 29 to 32 days.

Calendar month names in Hindu Calendars

Caitra	चैत्र
Vaiśākha	वैशाख
Jyeṣṭha	ज्येष्ठ
Āṣāḍha	आषाढ़
Śrāvaṇa	श्रावण
Bhādrapada	भाद्रपद
Āśvina	आश्विन
Kārtika	कार्तिक
Agrahāyaṇa	अग्रहायण
Pauṣa	पौष
Māgha	माघ
Phālguna	फाल्गुन

Since a lunar year is about 11 days shorter than the solar year, there is obviously a need to harmonise the two systems, so that important festivals fall during the same period every year and do not drift from season to season, as happens with many calendars. Hindu calendar makers solved this problem by adding a lunar month after every three years.

Purely lunar calendars, such as *Hijri* calendar followed by Muslims, do not have provision to reconcile the lunar year with the solar year. Their festivals and other holy days fall in different seasons. An example is the month of *Ramzan* or *Ramadan*, the month in which Muslims observe fasting for the whole month. *Ramzan* falls sometimes in winter, another time in summer, and yet another time in autumn; it keeps rotating from season to season.

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The rules for adding the extra month in the Hindu calendar are complicated. A simplified version of the rule is explained here.

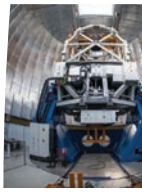
A solar year is about 365.25 days long, while a lunar year is about 354 days long. The difference of 11 days amounts to a month in about 2.7 years. So, in about 3 years it becomes necessary to accommodate one extra month to keep lunar year in step with the solar year. Note that the average length of a solar month is 30 days and 10.5 hours. On the other hand, a lunar month is 29.3 days. Thus, it is possible that there will be solar months which will have two new moons. On such occasions, the two lunar months are given the same name. Of these two lunar months, the one which does not contain a *Sankranti* is called *adhika* (अधिक, extra) month, or *malamāsa*. The year then consists of 13 months. During such a year, all the festivals occur about a month earlier. In the next two years, they drift back to later times in the year. Thus, the festivals oscillate and occur within a range of about one month.

The problem of a festival occurring on two successive days has to do with another element of the Hindu calendar. This one is called astronomical *tithi* (तिथि), or just simply, *tithi*. A *tithi* is a lunar date and determined by the positions of the Sun and the moon at any given time. The duration of a *tithi* is determined by the angular separation between the Sun and the moon as seen from the earth. The next *tithi* begins when their separation changes by 12 degrees. There are in all 30 *tithis*. A *tithi* can change at any time during the day.

The orbits of the Sun and the moon are elliptic. In an elliptic orbit, such as that of the moon around the earth, the orbital speed of an object is not uniform. Moreover, the motion of the Sun and the moon may suffer from various other perturbations. Thus, the duration of *tithis* is not constant. Its duration can vary between 19 and 26 hours. Some *tithis* may be longer than the time from one sunrise to the next (a day according to the Hindu calendar) and some may be shorter than this interval.

Since the *tithis* are of variable duration, quite often there is a change of *tithi* during a day. For example, according to a *Pañcaṅga* of 24 October 2017 for North India, the *tithi* at sunrise (6:27 AM) is fourth *tithi,* which could also be *Pañcamī* and it will change to the fifth *tithi,* which could also be *Caturthī* during the day.

A school of astronomers believes that the *tithi* at sunrise on a particular day should be considered the *tithi* for the whole day even if it changes to the next during the day. Considering the above example, according to this school of thought, the *tithi* for the whole day would be fourth. Now



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Answer the following questions by observing any Hindu calendar of the year 2019.

1. What was the time of sunrise and sunset on January 15, 2019?
2. In year 2019, find the *pakṣa* and *tithi* on your birthday.
3. On which date the *Caitra* month is starting in year 2019?

imagine that on a particular day the *tithi* at sunrise is N. If this *tithi* is longer than 24 hours, then it is possible that the *tithi* at sunrise next day will still be N. So, according to this school, a *tithi* gets repeated on two days. On the other hand, if the duration of the *tithi* (N + 1) is shorter than 24 hours, then the *tithi* at sunrise next day will be (N + 2); *tithi* (N + 1) will be missing.

The other school of thought believes that cognisance should be taken if a *tithi* changes during the day. According to these people, after 7:06 AM, the *tithi* on 24 October 2017 should be taken as *fifth* (पंचमी), though the *tithi* at the start of the day (sunrise 6:27 AM) was *fourth* (चतुर्थी). The difference between these two schools is the cause of confusion which results in a festival occurring on two consecutive days, or a festival occurring for a time shorter than a day.

Explanation of Eclipses

While seeking explanation of the eclipses, it must be appreciated that the astronomers needed to realise that the moon has no light of its own and it shines in the light of the Sun. They also needed fairly accurate knowledge of the distances of the Sun and the moon from the earth.

The eclipse of the Sun occurs when the moon comes in between the earth and the Sun. As a result, the light of the Sun does not reach some parts of the earth. An observer in these parts is not able to see a part or the whole of the Sun. The lunar eclipse occurs when the earth comes in between the moon and the Sun. It must be appreciated that these three bodies do not come in contact with one another; only one of these comes in between the other two during their natural motion. This means that there is no change in the Sun during the eclipse and it continues to emit the usual radiation. There is, thus, no way that the Sun emits special rays at the time of an eclipse which can harm us. Yet, this myth is widely prevalent. However, even during a solar eclipse the radiation of the Sun is strong enough to harm our eyes. Therefore, we should take adequate precautions while looking at the Sun.

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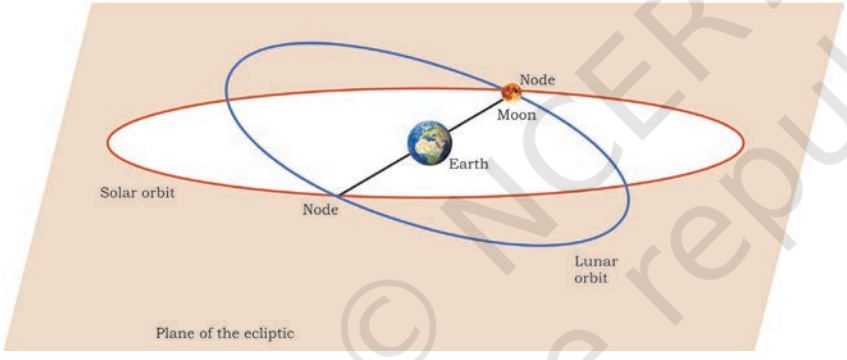
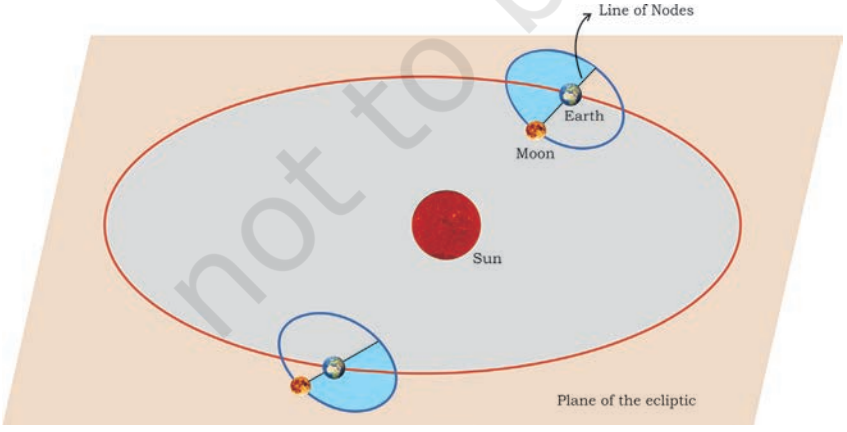
It was observed that the eclipses occur only on the days of full moon or on days of new moon. The correct explanation offered by the astronomers was that the planes of the orbits of the earth and the moon are inclined to each other. The two planes intersect along a line, called the line of nodes. The end points of this line are known as nodes.

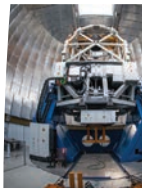
Only when the moon is at one of the nodes, can the eclipse occur. At other times, the Sun, moon and the earth are not in a straight line and the light of the Sun cannot be blocked. Incidentally, these nodes were named as *Rahu* and *Ketu*. Those people who did not understand the true significance of these nodal points had woven a myth around them which is still prevalent in some sections of our society. It was said that *Rahu* and *Ketu* are two demons to whom the Sun is indebted. Since the Sun is unable to clear the debt, these two demons appear periodically to ask the Sun to pay up. As the Sun is unable to pay, *Rahu* and *Ketu* devour the Sun and snuff out its light. Not only that, people also indulge in charity at the time of an eclipse to lessen the burden of the Sun. They also blow conches to chase away *Rahu* and *Ketu*.



Intersection of the orbital planes of the moon and the Sun. The figure shows the line of nodes and the two nodes.



Only when earth, moon and the Sun lie in the same plane, can eclipses occur.



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It is also believed that the period of an eclipse is inauspicious as, scientifically, more germs grow due to the absence of sunlight. To ward off the harmful effects of this period, people observe fast and throw away all perishable foods.

Uttarāyaṇa and Dakṣiṇāyana

Over a period of time it was noted by astronomers that the duration of sunlight in a day varied throughout the year. Longer sunlight hours coincided with the summer season while shorter sunlight periods occurred during the winter season. Further, it was also observed that the position of sunrise changed every day; it drifted towards North, then towards South and again towards North, completing one cycle in one year. It was found that in our part of the world the southward change in the position of sunrise indicated approaching winter, while the northward drift in the position of sunrise meant that summer was approaching. When the Sun started its northward journey after its maximum drift to south, it was said to enter *Uttarāyaṇa*. When the Sun begins to travel towards south from its maximum displacement towards north, it is said to enter *Dakṣiṇāyana*. *Uttarāyaṇa* was considered an auspicious event; it is celebrated even today as a festive occasion in our country.

There is an interesting story associated with *Uttarāyaṇa*. Bhīṣma, one of the main characters of *Mahābhārata*, was blessed with the power of choosing the time of his death. During the *Mahābhārata* war, Bhīṣma was wounded and lay on a bed of arrows. He declared that he would die only during the auspicious period of *Uttarāyaṇa*. It must be pointed out that about 2000 years back when the foundations of Indian astronomy were being laid, *Uttarāyaṇa* occurred around 14 January. However, due to precession, a slow change in the direction of the axis of earth's rotation, the event has drifted backwards and occurs now around 23 December.

You can also perform a simple activity (given on page 87) to observe how the position of sunrise changes with time.

Some Ancient Indian Astronomers

Āryabhaṭṭa

Āryabhaṭṭa is one of the most well-known ancient Indian astronomers. He was born in 476 C.E. somewhere near modern Patna. His work is compiled in *Āryabhaṭīyam*, perhaps the most influential book in the history of Indian astronomy. It is remarkable that he wrote this treatise when he was only 23 years of age. He introduced the use of large units of time, circular units of arc and units of distance. He

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Activity

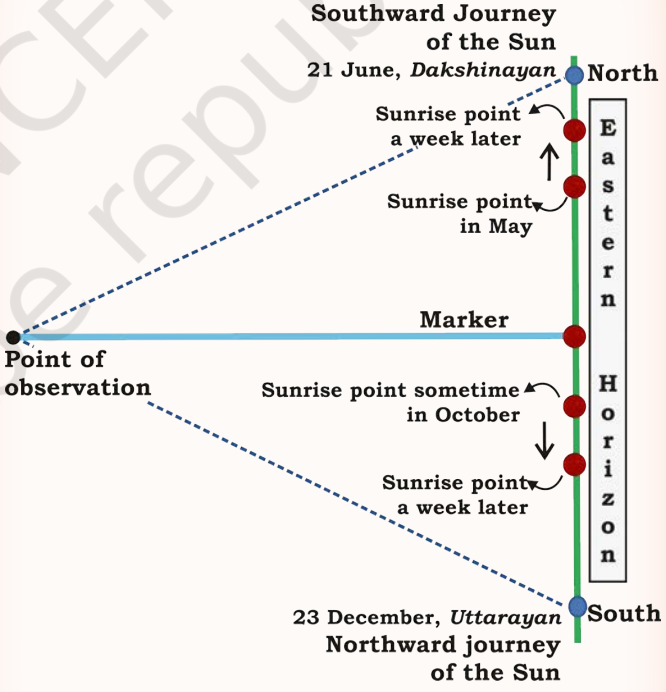
Changing position of the rising Sun—*Uttārayaṇa* and *Dakṣiṇāyana*

Choose a convenient place from where the sunrise can be observed and make a mark on the ground. Select a marker, such as a tree or an electric pole, to mark the position of the sunrise as observed from your selected position. Start early in the morning just as the Sun rises. Observe the position of the sunrise with respect to the marker. Repeat observation every week on the same day and at about the same time. It will be a good idea to photograph the rising sun from your chosen position such that the marker is also in the frame in every observation. You would notice that the position of sunrise keeps changing.

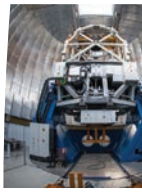
If you perform this activity for a whole year, you will find the position of the Sun changes continuously throughout the year. You will find that from the summer solstice, which is around 21 June, the position of the sunrise graudallly shifts towards south.

The time the Sun starts moving towards south marks the beginning of *Dakṣiṇāyana*. It remains in *Dakṣiṇāyana*, that is, it keeps moving towards south, till about 23 December which is the time of winter solstice. Thereafter, the Sun starts moving towards north. It is then said to be the beginning of *Uttarāyana*, the journey of the Sun northwards.

From the above account, it is clear that the tradition of astronomy, particularly practical and utilitarian astronomy, was very strong in ancient India. Indian astronomers were able to explain many phenomena associated with the Sun, moon, and other heavenly bodies. The explanation of many phenomena given by our astronomers are very close to what is presently accepted. It must be realised that all the complex calculations that the astronomers performed would not have been possible without parallel development in mathematics, particularly solution of algebraic equations and trigonometry. India boasted of some of the best mathematicians, whose works are now being appreciated in mathematical and scientific circles. The brief biographical sketches of some astronomers and mathematicians highlight many aspects of development in astronomy and mathematics in India.



Schematic diagram showing the position of Uttarayan and Dakshinayan



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was conversant with many attributes of planets and their orbits including their inclinations to the ecliptic plane and their orbital speeds. He suggested the scheme of adding a month in Indian calendar to reconcile the lunar and solar years. This additional month is known as *adhikamāsa*. We owe him the concept of week days.

Āryabhaṭṭa conceived the idea of celestial sphere to seek the explanation of ecliptic, celestial equator, zodiacal constellations and their relation, occurrence of day and night as also the shape of the earth. It appears that he was convinced that the earth is spherical in shape and rotates on its own axis. This results in the diurnal motion of the stars and planets. He devised a method, unique for his time, of expressing large numbers using alphabets which made it easy to remember them. He was perhaps the first Indian to determine the value of pi (π) up to the first four places of decimal, 3.1416, which is quite close to the present known value. Aryabhatta's work forms the basis for the work of later generations of astronomers. India honoured this illustrious astronomer by naming the first Indian satellite after him.

Varāhamihira

Varāhamihira was a contemporary of Āryabhaṭṭa, born in the beginning of sixth century C.E. When he was quite young, he met Āryabhaṭṭa, and was inspired to make the study of astronomy and astrology as his mission in life. His actual name was Mihira. He earned the title of *Varāha* from the king Vikramāditya because of his expertise in astrology. He studied all the previous systems of astronomy and compiled them into a single treatise, called *Pañcasiddhāntikā*, which facilitated the work of later astronomers. He also compiled a compendium called *Bṛhatsaṁhitā*. He considered *Sūryasiddhānta* to be the best astronomical system among the five systems prevalent at that time. It is remarkable that the revised versions of *Sūryasiddhānta* text are still used for astronomical reference. Varāhamihira is given the credit for stating that the equinoxes shift due to precession by 50.32 seconds of arc per year.

Bhāskara I

Bhāskara I, an eminent astronomer and mathematician of seventh century C.E., was born in 600 C.E., only a few decades after Āryabhaṭṭa. He not only compiled the works of Āryabhaṭṭa and other astronomers, but also commented on *Āryabhaṭīyam*. He improved on the sine series developed by Āryabhaṭṭa. Bhāskara's most important contribution to

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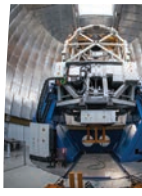
India in mathematics and astronomy was to establish the method of writing large numbers using positional values. He introduced the symbol circle for zero. The idea of positional values along with zero meant that the symbol for 5 could represent values 5, 50, 500 and so on, depending on where they are placed. His works are contained in two books, *Mahābhāskarīya* and *Laghubhāskarīya*. The second satellite launched by India was named after Bhāskara I.

Brahmagupta

Another great astronomer of ancient India, Brahmagupta, was born in seventh century C.E. His work on mathematics is of great importance, especially, the treatment of zero as a number. It was the first time that zero was recognised as a number. In addition, he dealt with positive and negative numbers, referring to them as fortune and debt respectively. He formulated the rules for addition, subtraction and multiplication of positive and negative numbers between themselves and with zero. These rules are valid even today. He also suggested rules for the combination of fractions. In arithmetic, his work covered the methods of finding squares, square-roots, cubes and cube-roots of integers. He established $\sqrt{10}$ (= 3.162277) as a good practical approximation for p (= 3.141593). Brahmagupta worked on quadratic equations and showed that a quadratic equation has two roots, one of which could be negative. He provided solutions of quadratic equations with two unknowns, the kind of problem which was attempted first in Europe in seventeenth century by Fermat, almost 1000 years later. Brahmagupta devoted a lot of his time to the development in geometry and trigonometry. He discovered a formula, now known as Brahmagupta formula, dealing with the area of a cyclic quadrilateral. He is also the author of Brahmagupta's theorem which deals with the diagonals of cyclic quadrilaterals. Most of his work is compiled in his famous book *Brahmaguptasiddhānta.*

Bhāskara II

Bhāskara II, more commonly known as Bhāskarācārya, was born in 1114 C.E. at Bijapur in Karnataka. He was the head of the astronomical observatory at Ujjain, which was at one time headed by the great astronomer and mathematician Brahmagupta. His major work on astronomy is contained in *Siddhāntaśiromaṇi* and *Karaṇakutūhala,* in which he compiled data on planetary positions, conjunctions and eclipses. In these works, he also described mathematical techniques and astronomical equipment used at that time.



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Bhāskarācārya compiled the work of Brahmagupta, filling the gaps in his work. He improved the decimal number system and suggested that division by zero is an infinite number. As an example he said that 3/0 = infinite number. He was perhaps the first to suggest the representation of unknown quantities in algebraic expressions by letters, as is the practice today. He also gave the general solution of Pell Equation ($x^2 = 1 + py^2$). His work in mathematics is compiled mainly in two books—*Līlāvati* and *Bījagaṇita*. He died in 1185 C.E. at Ujjain.

Kerala School of Astronomy

Here we will discuss the Kerala School of Astronomy and Mathematics, which flourished during fourteenth to sixteenth century C.E. During this time, a large number of astronomers and mathematicians were active in solving the problems of practical astronomy, most prominent of these being Parameśvara (1362–1455). Parameśvara mooted the idea of heliocentric model of the solar system, which was developed by Nīlakantha around 1500 C.E. (for comparison, note that the Copernicus' formulation of heliocentric model came in 1543 C.E.). One of the major achievements of the Kerala School was the discovery of a method to develop the infinite series of trigonometric functions. Initially the series were given without proof, but later a proof for power series for sine, cosine and arctangent functions was provided by Jyeṣṭhadeva. These mathematical developments were important for analysing astronomical observations. This was perhaps the first time in the world that a power series of a trigonometric function was developed. More importantly, this happened some 100 years before the development of calculus in Europe by Leibnitz and Newton. The work of Kerala School is now acknowledged worldwide. However, the credit of priority in proposing the heliocentric model of the solar system and the invention of calculus is still denied to Indian astronomers. The denial of the credit of priority in calculus is presumably on the ground that these astronomers developed the power series only for the functions that they needed for their astronomical calculations and did not generalise the method for any function.

Later Developments

During the early eighteenth century (A.D. 1723–1735) massive *yantramantra* or Jantar Mantar observatories were built at Delhi, Jaipur, Ujjain, Mathura and Varanasi by the Maharaja of Jaipur, Sawai Jai Singh. Each of them contains

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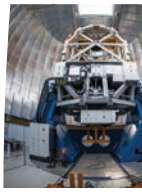
a sundial consisting of a gigantic triangular gnomon, and many other *yantras* for making astronomical observations of planets and stars. Some of the techniques used to calculate planetary positions and eclipses yielded remarkably precise results.

Astronomy in Modern India

We have learned of the contribution of ancient Indian astronomers to astronomy from the pre-vedic time to almost recent times. India has contributed immensely to both. In the modern times also, the progress in astronomy is based on the developments in basic sciences, new technological tools, efficient computing devices, high resolving power telescopes, etc. Like in ancient India, the modern India too is playing a significant role in the development of astronomy worldwide. For example, the Ooty Radio Telescope (ORT) has produced results on radio galaxies, quasars, supernovae and pulsars and aided in the discovery of several asteroids, etc. India's satellite Chandrayan-I has recently confirmed the presence of water on moon, and Giant Meter Wave Radio Telescope (GMRT) installed near Pune, discovered the massive supercluster of galaxies, which has been named as Saraswati supercluster.

Two views of New Delhi's Jantar Mantar
(Courtesy: Michel Danino, IIT Gandhinagar)



Indian Institute of Astrophysics (IIA), Bengaluru, has three major observatories. Vainu Bappu Telescope (VBT) at Kavalur, 1 m Carl Zeiss reflecting telescope, and 1.3 m JC Bhattacharya optical telescope. Kodaikanal Observatory was established in 1889 as a Solar Physics Observatory. It has various solar telescopes for the observations and study of the Sun. The third observatory named Indian Astronomical Observatory (IAO) is located at an altitude of 4517 m at

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The Ooty Radio Telescope

(Source: www.rac.ncra.tifr.res.in)

Hanle in Jammu and Kashmir. Its site is one of the world's highest observatory sites. It has 2 m telescope operating in optical and near infrared regions. This telescope is remotely operated from Bengaluru. It is named as Himalayan Chandra Telescope (HCT). IAO also has another telescope called HAGAR, which works in gamma ray region.

Aryabhatta Research Institute of Observational Sciences (ARIES), Nainital, also has three telescopes: Sampurnanand

Himalayan Chandra Telescope Observatory

(Courtesy: Dorje Angchuk, IAO, Hanle, figure provided by Indian Institute of Astrophysics, Bengaluru)

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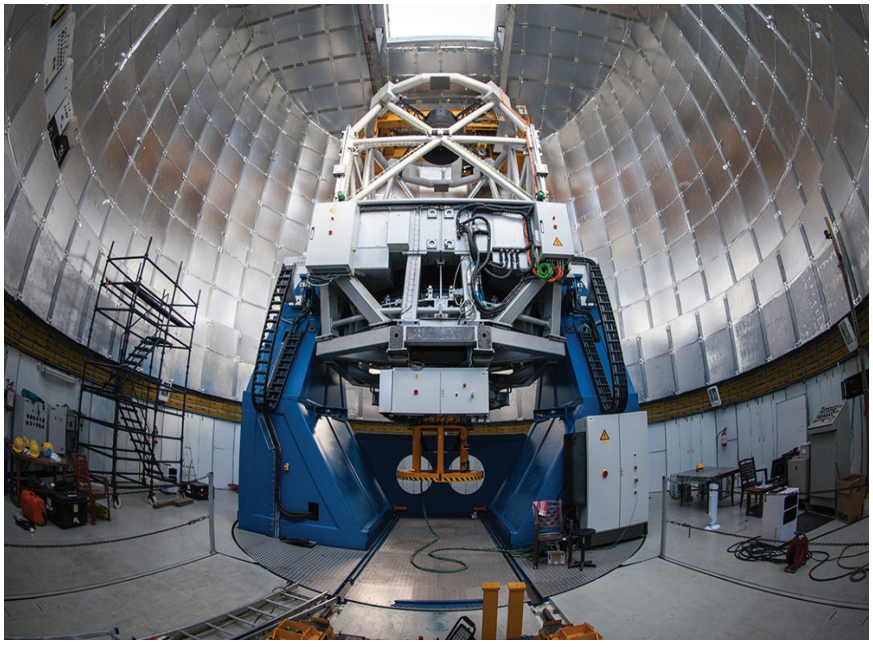


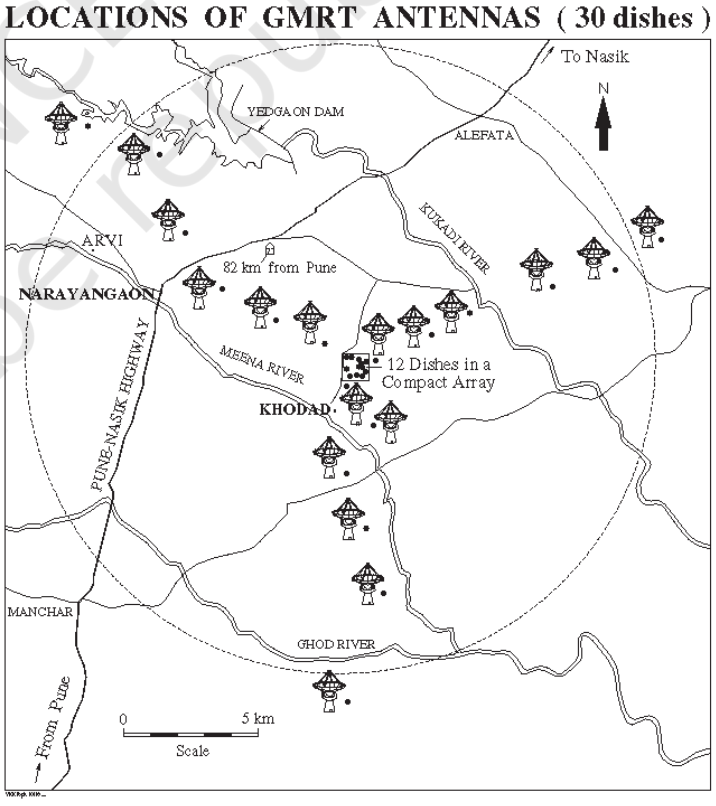
Devasthal Optical

(Source: www.aries.res.in)

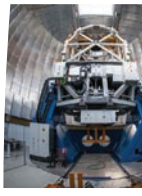
Telescope, Devasthal Fast Optical Telescope (DFOT), and Devasthal Optical Telescope (DOT). The DOT is a custom-built 3.6 m telescope. It is the largest telescope in India for the study of celestial objects at optical wavelengths. It was installed in 2016 at Devasthal, Nainital.

Inter University Center for Astronomy and Astrophysics (IUCAA), Pune, has Giravali Observatory located about 80 km away. The observatory has a reflecting telescope with a mirror of 2 m aperture. This observes radiations in optical and near infra-red regions of the electromagnetic spectrum.

National Center for Radio Astrophysics (NCRA), Pune, is a radio astrophysics research center. It has a Giant Metrewave Radio Telescope (GMRT) near Pune with 30 fully steerable dish type parabolic antennas arranged in Y-shaped array spread over a region of 25 km.



GMRT array of thirty dishes



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A close-up of a dish

(Source: gmrt.ncra.tifr.res.in)

The diameter of each antenna is 45 m. Presently, it is the world's largest radio telescope operating at meter wavelength. GMRT started its routine operation in 2000. The signals received from these antennas are synthesised together to gather information about astronomical sources.

Radio Astronomy Center, Ooty, which hosts the Ooty Radio Telescope, is situated near Udhagamandalam (Ooty). It provides stimulating environment for the front-line research in radio astronomy and astrophysics.

Physical Research Laboratory, Ahmedabad, has two observatories, at Mount Abu and Udaipur in Rajasthan. Mount Abu Infrared Observatory, has a 1.2 m telescope supported with instruments like infrared camera and spectrograph, imaging Fabry-Perot Spectrometer, optical polarimeter, etc. A solar research unit at Udaipur Solar Observatory (USO), Udaipur, has Solar Optical Telescope with 50 cm aperture. This unit is a part of Global Oscillation Network Group (GONG) for studying the Sun throughout the day.

India is also playing a significant role and contributing globally to astronomy. It has become a joint partner for the extremely large telescope, the Thirty Meter Telescope (TMT). TMT will enable the scientists to study fainter objects in the universe. These objects, being far away from us, tell us the state of the universe in the distant past and provide information about the evolution of the universe. Also, it will allow us to study nearby objects in finer details, objects like undiscovered planets and other objects in our Solar System and other such extrasolar systems. This project is expected to benefit Indian industries, and research and development centers. It is expected that the TMT images would be twelve times sharper than those from the Hubble Space Telescope.

A team of Indian Scientists was a part of the group which announced in 2016, the discovery of gravitational waves predicted by Einstein. India is also joining the international group of Laser Interferometer Gravitational-Wave Observatory (LIGO). LIGO is a large-scale experiment to detect cosmic gravitational waves and to develop them as an astronomical tool to study the evolution of the universe.

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While having thousands of dishes and upto 10 lakhs antennas spread in an area of 12 km, the proposed is designed to survey the entire sky much faster and in much greater detail than any other existing system. India is also a part of the international Square Kilometer Array (SKA) project. Its construction is expected to begin in 2019 in Africa and Australia. Preliminary observations are expected from around 2025.

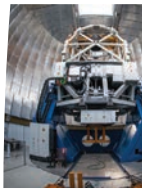
Exercises

1. Write a few sentences on the development of astronomy in India.
2. Briefly describe the contribution of Āryabhaṭṭa to astronomy.
3. What is the significant contribution of Kerala School to astronomy?
4. Why eclipses occur only on full moon day or on new moon day? Explain.
5. Explain the importance of *tithi* in Indian Calendar.
6. Identify the situations in which solar eclipse and the lunar eclipse occur.
7. Explain why the shadows seen in the photographs of eclipses are circular?
8. Name a few Indian institutions where research in radio astronomy is carried out.
9. List the locations of large optical telescopes in India.
10. What is the full form of LIGO? Discuss its importance.
11. It is said that astronomy is the study of the past. Comment.
12. Name the city where Sawai Jai Singh observatory is built.
13. Match the following:

Sūryasiddhānta	Moon
Lunar Year	Jantar Mantar observatories
Nakśatras	Varāhamihira
Nilkantha	354 days
Rāśi	Udaipur
GONG	Ecliptic
Jai Singh	Heliocentric solar system

Project Ideas

1. Study some of the main instruments of the Jantar Mantar (Delhi or Jaipur) and try to explain their functions and principles. Your project should underline the historical importance and technical principles of the Jantar Mantar. You may prepare a power point presentation.



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2. Make a list of at least ten major Indian astronomers; mention their contributions and their impact on the society around them.
3. Draw a timeline of Indian astronomy, including some of its most famous representatives.
4. Look at the night sky and try to identify as many stars and constellations as possible.

Extended Activities

- Make a working model for determining the true North-South direction at your location. For this, you can use the shadows of a stick.
- Draw the different phases of moon at your location on different nights (you may also take photographs!) and then explain the formation of these phases.
- Attempt to make a scale model of the solar system.
- Visit the nearest planetarium and acquire the basic knowledge of astronomy, beginning with our solar system. Reflect on how much the ancients (not just in India) were able to observe and calculate despite having no telescopes.
- Learn to observe the night sky and identify the main constellations (not just the *nakshatras*), both by their international and Indian names.
- Construct a sundial; observe the variations of the shadow not only in the course of the day, but in the course of the year. Indian astronomers researched the equations of the gnomon and shadow extensively; try to refer to some of their research and put it in modern terms.

Internet Resources and Apps

(All URLS Accessed in October 2018)

http://jantarmantar.org

www.skyandtelescope.com

www.space-india.com;

https://www.iiap.res.in;

https://www.aries.res.in;

https://www.ncra.tifr.res.in;

https://www.icts.res.in/program/AS2012;

https://nptel.ac.in/courses/121104006/

www.euhou.net;

www.ipsindia.org;

www.astronomy.com/News-Observing

www.astronomynow.com;

www.sky-map.org

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http://outreach.as.utexas.edu/marykay/highschool/hs.html

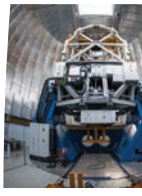
http://galileo.phys.virginia.edu/classes109N/lectures/greek_astro.htm

https://www.youtube.com/watch?v=n-oITe1dsdU; ...= KyExE-GXg54; ...=Y7dQoSkoN0g

To study the celestial objects and to and enjoy all the activities that are happening up in the sky, one can simply download stargazing apps on to Android or iOS powered devices. A list of some such Apps is given here:

Stars Chart; Sky View; Distant Suns; NASA App; Pocket Universe; ISS Detector; Star & Planet Finder; Night Sky Lite; Solar Walk; SkySafari 5; SkEye; Heavens-Above;

Stellarium Mobile Sky Map; Satellite Augmented Reality; GoSkyWatch Planetarium; Solar System Explorer 3D; Star Tracker – Mobile Sky Map; SkyMap; ZSD; India Sky Map, etc.



Suggested Readings

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Glossary

Astronomy: The scientific study of the celestial objects, their positions, their motions, their radiations reaching on earth and their nature.

Eclipse: The darkening of one non-luminous object by the shadow of another non-luminous object. Solar eclipse or 'eclipse of Sun' occurs when the Sun, the moon, and the earth are in line. In this situation the shadow of the moon falls on the earth. Lunar eclipse or 'eclipse of the moon' is said to occur when the shadow of the earth falls on the moon.

Sidereal period of a year: The 'year' of a planet. It is the actual period of its revolution round the Sun. The sidereal period of the earth is 365.256 days. The sidereal period of mars is 686.980 days. The sidereal period of the jupiter is about 12 years.

Solstice: The points at which the Sun reaches its greatest declination. The winter solstice is the point (around 23 December) when the position of sunrise gradually shifts towards north. The summer solstice is the point (around 21 June) when the position of sunrise gradually shifts towards south.

Spectrometer: In astronomical sense, it is an instrument used for measuring the energy distribution of a particular type of radiation.

Supercluster: A supercluster is an association of galaxy clusters and groups. It is composed of a few rich clusters and many poorer groups and isolated galaxies.

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Mathematics in India

6

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Little is known to us at present regarding the achievements of the early Indian mathematicians and our indebtedness to them. A look at the works done in mathematics by Indians in the ancient period makes one wonder about their achievements. It also makes us realise as to how important it was considered in the ancient period in India. For instance, it is now generally admitted that the decimal place value system of numeral notation was invented and first used by the Indians.

This chapter will give a fairly good idea about the growth and development of some of the major areas of mathematics in India from the earliest known times down to the seventeenth century of the Christian era.

A Glimpse of Ancient India

The discoveries at Mohenjodaro reveal that as early as 3,000 B.C., the inhabitants of the land of the Sindhu lived a highly organised life. In fact, they were more advanced than any other people of that period. The *Brāhmaṇa* literature (2000 B.C.) which follows the Vedas, is partly ritualistic and partly philosophical. Continuous progress and brilliant achievements were made after this *Brāhmaṇa* period for more than two thousand years. The culture of the science of mathematics or of any other branch of knowledge, was not considered to be a hindrance to spiritual knowledge.

Importance to the culture of *Gaṇita* (mathematics) is also given by the Jainas. Their religious literature includes *gaṇita anuyoga*. The knowledge of *Saṁkhyāna* is stated to

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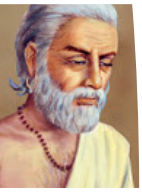

The *Brāhmaṇas* are a collection of ancient *Indian* texts with commentaries on the hymns of the four Vedas.

be one of the principal accomplishments of the Jaina priest. In Buddhist literature too, arithmetic (*gaṇanā saṁkhyāna*) is regarded as the first and the noblest of the arts. All these will give a fair idea of the importance and value set upon the culture of *gaṇita* in ancient India.

Development of Numerical Symbolism

From the very early times, ten has formed the basis of numeration in India. It is also characteristic of India, that a long series of number names have been found of very high numerals. The reference to the use of numerical denominations as big as 1012 in the *Yajurveda Saṁhitā* and in several other Vedic works, offer sufficient grounds for concluding that, even at that remote period, the Indians must have possessed a well developed system of numerical symbols. The writings on the inscriptions of Asoka show that in his time the use of numerical symbols in India was quite common.

The variations in the forms of the numerical signs suggest that the symbols had been in use for a long time. The *Brāhmī* Numerals are a purely Indian invention. Our knowledge of these symbols goes back to the time of King Asoka (300 B.C.), whose vast dominions included the whole of India and extended in the north upto Central Asia. A number of inscriptions containing numerals and dating from A.D. first or second century are found in a cave in the district of Nasik of the then Bombay presidency. The numbers 1, 2 and 3 of the Brahmi notation were denoted by one, two and three horizontal lines placed one below the other.

It is clear now that India has a long tradition of mathematics. However, the period A.D. 500–1200 is extremely interesting in the sense that this is known as the Golden (*Siddhāntic*) period of Indian mathematics. It begins with Aryabhata I, who was born in A.D. 496, a pioneer mathematician known for his systematic collection and systematisation of knowledge, and ends with Bhaskara II born in A.D. 1114 who put the knowledge of mathematics on a solid foundation. The mathematicians in between them—Varāhamihira (A.D. 505), Bhāskara I (A.D. 600), Brahmagupta (A.D. 628), Mahāvīra (A.D. 850), Śrīdhara (A.D. 850), Śrīpati (A.D. 1039), were equally famous.

Āryabhaṭa
Source: *Mathematics*, Class XI, NCERT

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Āryabhaṭīya of Āryabhaṭa I has two sections—*Daśagtikā* (some essential parameters on decimal scale and discovery of zero, elements of trigonometry) and *Gaṇita* (eight fundamental operations, plane geometry, algebraical equations and their solutions). Brahmagupta has two sections in his *Brahmasphuṭasiddhānta*—*Gaṇita* (mathematics) and *Kuṭṭaka* (pulveriser), whereas Bhāskara II wrote two separate works, *Līlāvatī* (mathematics) and *Bījagaṇita* (algebra), which show how the knowledge of mathematics has expanded in volumes in this period.

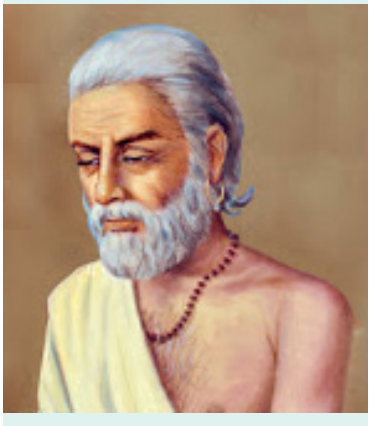
The symbol for zero was discovered by Āryabhaṭa I (born in A.D. 496) in connection to the decimal expression of numbers. Āryabhaṭa I says, "the vacant places should be filled up with a circle" which looks like '*śūnya*'. This has been illustrated by his commentator Bhaskara I (A.D. 600). This indeed brought a revolution in mathematical computation and simplified the whole technique of expressing numbers with nine numerical symbols and zero.

Arithmetic

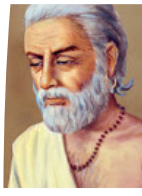
Arithmetic forms the major part of *pāṭigaṇita*. The word *pāṭigaṇita* is a compound word formed from the words *pāṭi*, meaning 'board,' and *gaṇita*, meaning 'science of calculation'. Thus it means the science of calculation which requires the use of writing material (the board). The carrying out of mathematical calculations was sometimes called *dhūli-karma* ('dust-work'), because the figures were written on dust spread on a board or on the ground. According to Brahmagupta there are twenty operations and eight determinations in *pāṭigaṇita*. He says: "He who distinctly and separately knows the twenty logistics, i.e., addition, etc., and the eight determinations including (measurement by shadow) is a mathematician." Āryabhaṭa I (A.D. 499) was the first to include a section on mathematics in his Siddhānta, the *Āryabhaṭīya*. Brahmagupta (A.D. 628) followed Āryabhaṭṭa in this respect, and after him it became the general fashion to include a section on mathematics in a Siddhānta work.

In India conciseness of composition, especially in scientific matters, had greater value in the eyes of the learned. It is for this reason that the Indian treatises contain only a brief statement of the known formulae and results, sometimes so concisely expressed as to be hardly understandable. This compactness is more pronounced in the older works; for instance, the exposition in the *Āryabhaṭīya* is more compact than in the later works.

The eight fundamental operations of ancient *gaṇita* are: (1) addition, (2) subtraction, (3) multiplication, (4) division,



Brahmagupta



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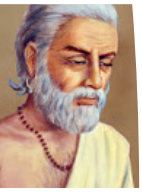

(5) square, (6) square-root, (7) cube and (8) cube-root. Aryabhatta I gave the rules for finding the square and cube-roots only, whilst Brahmagupta gave the cube-root rule only.

That all mathematical operations are variations of the two fundamental operations of addition and subtraction, was recognised by the Indian mathematicians from early times. Bhāskara I states that—"All arithmetical operations resolve into two categories, though usually considered to be four. The two main categories are increase and decrease. Addition is increase and subtraction is decrease. These two varieties of operations permeate the whole of mathematics (*gaṇita*)." So previous teachers have said: "Multiplication and evolution are particular kinds of addition; and division and involution that of subtraction. Indeed every mathematical operation will be recognised to consist of increase and decrease."

Addition

Aryabhata II defines addition as— "The making into one of several numbers is addition". The ancient name for addition is *saṁkalita* (made together). Other equivalent terms commonly used are *saṁkalana* (making together), *miśraṇa* (mixing), *sammelana* (mingling together), *prakṣepaṇa* (throwing together), *saṁyojana* (joining together), *ekīkaraṇa* (making into one), *yukti, yoga* (addition) and *abhyāsa,* etc. The word saṁkalita has been used by some writers in the general sense of the sum of a series.

In all mathematical and astronomical works, knowledge of the process of addition is taken for granted. Very brief mention of it is made in some later works of elementary character. Thus Bhāskara II says in the Līlāvatī: "Add the figures in the same places in the direct or the inverse order." In the direct process of addition referred to above, the numbers to be added are written down, one below the other, and a line is drawn at the bottom, below which the sum is written. At first the sum of the numbers standing in the units place is written down, thus giving the first figure of the sum. The numbers in the tens place are then added together and their sum is added to the figure in the tens place of the partial sum standing below the line and the result is substituted in its place. Thus the figure in the tens place of the sum is obtained, and so on.

In the inverse process of addition, the numbers standing in the last place (extreme left) are added together and the result is placed below this last place. The numbers in the next place are then added and the process continues. The numbers of the partial sum are corrected, if necessary, when the figures in the next vertical line are added. For instance,

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if 12 be the sum of the numbers in the last place, 12 is put below the bottom line, 2 being directly below the numbers added; then, if the sum of the numbers in the next place is 13 (say), 3 is placed below the figures added and 1 is carried to the left. Thus, the figure 2 of the partial sum 12 is rubbed out and substituted by 3. Let us find 26 + 57.

Direct Process

Step 1:	Step 2:	Step 3:	Step 4:
2 6	2 6	2 6	2 6
+ 5 7	+ 5 7	+ 5 7	+ 5 7
1 3	7 13	(7+1) 3	8 3

Inverse Process

Step 1:	Step 2:	Step 3:	Step 4:
2 6	2 6	2 6	2 6
+ 5 7	+ 5 7	+ 5 7	+ 5 7
7	7 13	(7+1) 3	8 3

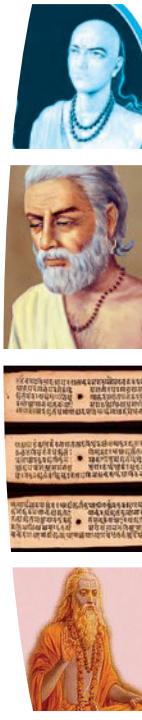
Q. Perform the following additions by the above mentioned methods. Tally your answers using the present day method.
(i) 37+49 (ii) 57+69 (iii) 74+36

Subtraction

Aryabhata II (A.D. 950) defines subtraction as:

"The taking out (of some number) from the *sarvadhana* (total) is subtraction; what remains is called *Śeṣa* (remainder)." The terms *vyutkalita* (made apart), *vyutkalana* (making apart), *śodhana* (clearing), *patana* (causing to fall), *viyoga* (separation), etc., have been used for subtraction. The terms *śeṣa* (residue) and *antara* (difference) have been used for the remainder. The minuend has been called *sarvadhana* or *viyojya* and the subtrahend *viyojaka*.

Bhaskara II gives the method of subtraction thus: "Subtract the numbers according to their places in the direct or inverse order." The direct process is explained with the help of an example say, 1000 – 360. Six cannot be subtracted from the zero standing in the tens place, so taking ten and subtracting six from it, the remainder (four) is placed below (six), and this ten is to be subtracted from the next place.



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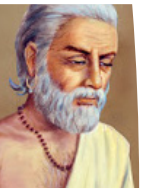

For, as the places of unit, etc., are multiples of ten, so the figure of the subtrahend that cannot be subtracted from the corresponding figure of the minuend is subtracted from ten, the remainder is taken and this ten is deducted from the next place. In this way this ten is taken to the last place until it is exhausted with the last figure. In other words, numbers up to nine occupy one place, the differentiation of places begins from ten, so it is known 'how many tens are here in a given number', and therefore, the number that cannot be subtracted from its own place is subtracted from the next ten, and the remainder taken."

The inverse process is similar, the only difference being that "it begins from the last place of the minuend, and the previously obtained partial differences are corrected, if required. The process is suitable for working on a Pāṭi (board) where figures can be easily rubbed out and corrected."

Q. Perform the subtractions:
(i) 4000 – 230 (ii) 4325 – 567 (iii) 345 – 56

Multiplication

The common Indian name for multiplication is *guṇana*. This term appears to be the oldest as it occurs in Vedic literature. The terms *hanana*, *vadha*, *kṣaya*, etc., which mean 'killing' or 'destroying', have also been used for multiplication. These terms came into use after the invention of the new method of multiplication with the decimal place-value numerals; for in the new method, the figures of the multiplicand were successively rubbed out (destroyed) and in their places the figures of the product were written. Synonyms of *hanana* (killing) have been used by Aryabhata I (A.D. 499), Brahmagupta (A.D. 628), Śrīdhara (A.D. 750), and later writers. These terms also appear in the *Bakhshali* manuscript. The ancient terminology proves that the definition of multiplication was 'a process of addition resting on repetition of the multiplicand as many times as is the number of the multiplicator.' This definition occurs in the commentary of the *Āryabhaṭīya* by Bhāskara I.

The multiplicator was termed *guṇya* and the multiplier as *guṇaka* or *guṇakara*. The product was called *guṇana-phala* (result of multiplication) or *prartyutpanna* ('reproduced', hence in arithmetic 'reproduced by multiplication').

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Methods of Multiplication

Brahmagupta mentions four methods: (1) *gomutrikā*, (2) *khaṇḍa*, (3) *bheda*, and (4) *iṣṭa*. Āryabhata II (A.D. 950) did not name the method and stated: "Place the first figure of the multiplier over the last figure of the multiplicand, and then multiply successively all the figures of the multiplier by each figure of the multiplicand."

Śrīpati (A.D. 1039) gives the name *kapaṭa-sandhi* and states: "Placing the multiplicand below the multiplier as in the junction of two doors, multiply successively (the figures of the multiplicand) by moving it (the multiplier) in the direct or inverse order."

The following illustrations explain the two processes of multiplication according to the *kapaṭa-sandhi* plan:

Direct Process: This method of working does not appear to have been popular. It has not been mentioned by writers after the eleventh century, Śrīpati (A.D. 1039) being the last writer to mention it.

Example: Multiply 135 by 12.

The numbers are written down on the *Pāṭi* thus:

12
135

The first (i.e., rightmost) digit of the multiplicand (5) is taken and multiplied with the digits of the multiplier. Thus

5×2= 10; 0 is written below 2, and 1 is to be carried over.

Then 5×1=5; adding 1 (carried over), we get 6. The number 5, which is no longer required is rubbed out and 6 is written in its place. Thus, we have:

12
1360

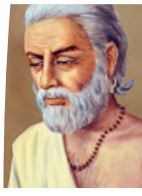
The multiplier is then moved one place towards the left, and we have:

12
1360

Now, 12 is multiplied by 3. The details are: 3×2=6; this 6 added to the figure 6 below 2 gives 12. 6 is rubbed out and 2 is substituted in its place. 1 is carried over. Then 3×1=3; 3 plus 1 (carried over)=4. 3 is rubbed out and 4 substituted. After the multiplier 12 has been moved to another place towards the left, the figures on the *Pāṭi* stand thus:

12
1420

Then, 1×2=2; 2+4=6; 4 is rubbed out and 6 substituted. 1×1= 1, which is placed to the left of 6.



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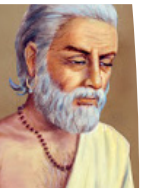

12
1620

As the operation has ended, 12 is rubbed out and the *Pāṭi* has the product 1620.

Thus the numbers 12 and 135 have been killed and a new number 1620 is born (*pratyutpanna*).

Inverse Process: There appears to have been two varieties of the inverse method.

(a) In the first, the numbers are written thus:

12
135

Multiplication begins with the last (i.e., left most) digit of the multiplicand.

Thus 1×2=2; 1 is rubbed out and 2 substituted; then 1×1=1, this is written to the left; the multiplier 12 is moved to the next figure. The work on the *pāṭi* will now be:

12
1235

Then, 3×2=6; 3 is rubbed out and 6 substituted; then 3×1=3 and 3+2=5; 2 is rubbed out and 5 substituted in its place. The multiplier having been moved, the work on the *pāṭi* now is:

12
1565

Now, 5×2= 10; 5 is rubbed out and 0 substituted in its place; then 5×1=5; 5+1=6; 6+6=12; 6 is rubbed out and 2 substituted, and 1 is carried over; then 1+ 5 = 6, 5 is rubbed out and 6 substituted in its place. The *Pāṭi* has now 1620 as the product (*pratyutpanna*). The figures to be carried over are noted down on a separate portion of the *pāṭi* and rubbed out after addition.

(b) In the second method, the partial multiplications (i.e., the multiplications by the digits of the multiplicand) are carried out in the direct manner. These partial multiplications, however, seem to have been carried out in the inverse way, this being the general fashion.

Multiply the following numbers using direct and indirect processes. Check the answer using the modern day multiplication technique:
(i) 345 × 27 (ii) 678 × 45 (iii) 756 × 98

Division

Division seems to have been regarded as the inverse of multiplication. The common Indian names for the operation are *bhāgahara*, *bhājana*, *haraṇa*, *chedana*, etc. All these terms

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literally mean 'to break into parts,' i.e., 'to divide', except *haraṇa*, which means 'to take away'. This term shows the relation of division to subtraction. The dividend is termed as *bhājya*, *hārya*, etc., the divisor is termed as *bhājaka*, *bhāgahara* or simply *hara*, and the quotient is called as *labdhi, which means* 'what is obtained' or *labdha*.

The Method of Long Division

The following example will serve to illustrate the Indian method of performing the operation on a *pāṭi*:

Example: Divide 1620 by 12.
The divisor 12 is placed below the dividend in this way:

1620
12

The process begins from the extreme left of the dividend, which is 16 in this case. This 16 is divided by 12. The quotient 1 is placed in a separate line. Thus, the partial quotient 1, being written, the procedure is:

1620 — 1
12 — line of quotients

16 is rubbed out and the remainder 4 is substituted in its place. The subtraction is made by rubbing out figures successively as each figure of the product to be subtracted is obtained, the figures on the *pāṭi* are:

420 — 1
12 — line of quotients

The divisor 12 is now moved one place to the right giving:

420 — 1
12 — line of quotients

42 is then divided by 12. The resulting quotient 3 is set in the 'line of quotients', 42 is rubbed out and the remainder 6 substituted in its place. The figures now stand thus:

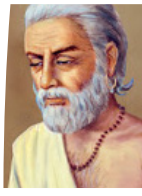
60 — 13
12 — line of quotients

Moving the divisor one place to the right, we have

60
12

After performing the division as before, the resulting quotient 5 is set in the 'line of quotients' and 60 is rubbed out leaving no remainder. The line of quotients has 135, which is the required result.

The above process, when the figures are not obliterated and the successive steps are written down one below the other, it becomes the modern method of long division. The



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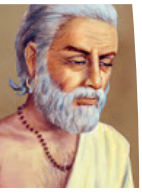

method seems to have been invented in India about the fourth century A.D., if not earlier.

(i) Divide 1771 by 23 (ii) Divide 9728 by 32
(iii) Divide 6930 by 45

Fractions

In the oldest known work, the *Ṛgveda,* the fractions one-half *(ardha)* and three-fourths *(tri-pāda)* occur. In a passage of the *Maitrāyaṇi Saṁhitā,* are mentioned the fractions one-sixteenth *(kala),* one-twelfth *(kustha),* one-eighth *(sapha)* and one-fourth *(pāda).* In the earliest known mathematical work, the *Sulbasūtra,* fractions have not only been mentioned, but have been used in the statement and solution of problems.

The occurrence of the fraction three-fourth in the *Ṛgveda* is probably the oldest record of a composite fraction known to us. The Sanskrit compound *tri-pāda* literally means 'three feet'. Used as a number, it denotes that the measure of the part considered bears the same ratio to the whole as three feet of a quadruped bear to the total number of its feet. The term *pāda,* however, is a word numeral for one-fourth, and the compound *tri-pāda* is formed exactly on the same principle as the English term three-fourth. In the *Sulba,* unit fractions are denoted by the use of a cardinal number with the term *bhāga* or *aṁśa;* thus *pañca-daśa-bhāga* (fifteen parts) is equivalent to one-fifteenth, *sapta-bhāga* (seven parts) is equivalent to one-seventh, and so on. The use of ordinal numbers with the term *bhāga* or *aṁśa* is also quite common, e.g., *pañcama-bhāga* (fifth part) is equivalent to one-fifth. Sometimes the word *bhāga* is omitted, probably for the sake of metrical convenience. Composite fractions like 3/8 and 2/7 are called *tri-aṣṭama* (three-eighths) and *dvi-saptama* (two-sevenths) respectively.

Square

The Sanskrit term for square is *varga* or *kṛti.* The word *varga* literally means 'rows' or 'troops' (of similar things). But in mathematics, it 'ordinarily denotes the square power and also the square figure or its area'. Thus Aryabhata I says: "A square figure of four equal sides and the (number representing its) area are called *varga.* The product of two equal quantities is also *varga.*"

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The term *kṛti* literally means 'doing,' 'making' or 'action'. It carries with it the idea of specific performance, probably the graphical representation. Both the terms *varga* and *kṛti* have been used in the mathematical treatises, but preference is given to the term *varga*.

The following is the method of working on the *Pāṭi*, the process beginning from the last place, according to Sridhara, Mahavira, Bhaskara II and others:

Example: Find the square of 125.

The number is written down:

125

The last digit from the left is 1. Its square is placed over itself.

1
125

Then twice the last digit (i.e., 1) is 2×1=2; placing it below the rest of the figures (below 2 or below 5 accordingly as per the direct or inverse method of multiplication, whichever is used) and rubbing out the last digit 1, the work on the *pāṭi* appears as:

1
25
2

Performing multiplication by 2 (below, i.e., 25×2 =50) and placing the results over the respective figures, removing out 2, we get:

150
25

One round of operation is completed. Next, moving the remaining digits i.e., 25, to the right by one place, we have:

150
25

Now, the process is repeated, i.e., the square of the last digit (2) is placed over itself (by rubbing 0) giving:

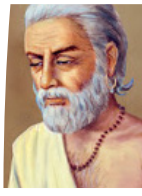
154
25

Then, placing twice the last digit (i.e., 2×2=4) below the rest of the digits and then rubbing out 2, we have:

154
5
4

Performing multiplication, 4×5 = 20, and placing it over the corresponding figure 5, (i.e., 0 over 5 and 2 carried to the left), the work on the *pāṭi* appears as:

1560
5



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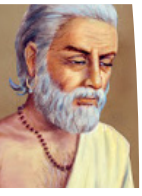

Thus, the second round of operations is completed. Then moving 5, we have:

1560
5

Squaring 5 we get 25, and placing it over 5, replacing 0 (i.e., 5 over 5 and 2 carried to the left), we have:

15625
5

As there are no remaining figures, the work ends.

5 being rubbed out, the *pāṭi* has 15625, the required square.

Q. Find the squares of the following numbers using the above method. Check the answers using the present day method of finding square.
(i) 234 (ii) 356 (iii) 487
(iv) 753 (v) 269

Square-Root

The Hindi terms for the 'root' are *mūla* and *pāda*. The usual meaning of the word *mūla* in Sanskrit literature is the 'root' of a plant or tree; but figuratively the foot or lowest part or bottom of anything. Its other meanings are basis, foundation, cause, origin, etc. The word *pāda* means 'the lower part of the leg' (figuratively the lower part or basis of anything), foot, part, portion, side, place, cause, a square on a chess-board, etc. The meanings common to both the terms are foot, the lowest part or basis of anything, cause or origin. It is, therefore, quite clear that the Indians meant by the term *varga-mūla* (square-root) the cause or origin of the square or the side of the square (figure).

The description of the method of finding the square-root is given in the Āryabhaṭīya very concisely thus:

"Always divide the even place by twice the square-root (upto the preceding odd place); after having subtracted from the odd place the square (of the quotient), the quotient put down at the next place (in the line of the root) gives the root."

The method may be illustrated thus:

Example: Find the square-root of 54756.

The odd and even places are marked by vertical and horizontal lines. The different steps are then as indicated hereby.

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	– –	
	| | |	
	5 4 7 5 6	
Subtract the square of a number just less than 5.	4	Root = 2 (I)
	4) 1 4 (3	
Divide by twice the root at I (i.e. 2).	1 2	Placing quotient at the next place, the root =23 (II)
	2 7	
Subtract square of the quotient i.e., 3	9	
Divide twice the root at II (i.e. 23)	46) 18 5 (4 18 4	Placing quotient at the next place, the root = 234 (III)
Subtract square of the quotient i.e., 4	1 6 1 6	

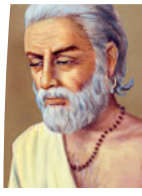
The process ends. The root is 234.

Find square roots of the following numbers by using the above method. Check the answer using present day method.
(i) 128164 (ii) 210681 (iii) 611524

Geometry

The oldest known mathematics texts in existence are the *Sulbasūtras* of *Baudhāyana*, *Āpastamba* and *Kātyāyana*, which form part of the literature of the Sūtra period of the later Vedic age. The *Sulbasūtras* had been estimated to have been composed around 800 B.C. But the mathematical knowledge recorded in these sutras are much more ancient; for the *Sūlba* authors emphasise that they were merely stating facts already known to the composers of the Brāhmaṇas and Saṁhitās of the early Vedic age. The *Sulbasūtras* give a compilation of the results in mathematics that had been used for the designing and construction of the various elegant Vedic fire altars. The altars had rich symbolic significance and had to be constructed with accuracy. The designs of several of these brick-altars are quite interesting, for instance, there are constructions depicting a falcon in flight with curved wings, a chariot-wheel complete with spokes or a tortoise with extended head and legs. In *Sulbasūtra*, the types of triangles namely *Sama*, *dvisama* and *viṣamatribhūja* were basically equilateral, isosceles and scalene triangles.

Baudhayana



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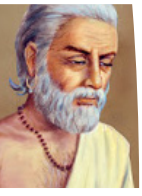

Throughout history, plane geometry has been known to stand on two important pillars having applications: (i) the result popularly known as the 'Pythagoras theorem', and (ii) the properties of similar figures. In the *Sulbasūtras*, a statement of the Pythagoras theorem can be seen alongwith its applications in various geometric constructions, such as construction of a square equal (in area) to the sum, or the difference of two given squares, or to a rectangle.

Āryabhaṭa I gave the correct formulae for area or perimeter of all the common geometrical figures, whereas Brahmagupta gave correct formulae for area of the triangle; also of the cyclic quadrilateral when sides are known, and diagonals of the cyclic quadrilateral.

Algebra

The Indian name for the science of algebra is *Bījagaṇita*. *Bīja* means 'element' or 'analysis' and *gaṇita* means 'the science of calculation'. Thus *bījagaṇita* literally means 'the science of calculation with elements' or 'the science of analytical calculation'. Brahmagupta (A.D. 628) calls algebra *kuṭṭaka-gaṇita*, or simply *kuṭṭaka*. The term *kuṭṭaka*, meaning 'pulveriser', refers to a branch of the science of algebra dealing particularly with the subject of indeterminate equations of the first degree. It is interesting to find that this subject was considered so important by the Indians that the whole science of algebra was named after it in the beginning of the seventh century. Algebra is also called *avyakta-gaṇita,* or 'the science of calculation with unknowns' (*avyakta*=unknown) in contradistinction to the name *vyakta-gaṇita,* or 'the science of calculation with knowns' (*vyakta*=known) for arithmetic including geometry and mensuration.

Importance of Algebra

The early Indians regarded algebra as a science of great utility. In the opening verses of his treatise on algebra, Brahmagupta observes:

"Since questions can scarcely be known (i.e., solved) without algebra, therefore, I shall speak of algebra with examples. By knowing the pulveriser, zero, negative and positive quantities, unknowns, elimination of the middle term, equations with one unknown, factum and the square-nature, one becomes the learned professor (*ācārya*) amongst the learned."

Similarly Bhāskara II (1150 A.D.) writes—"What the learned calculators (saṁkhyāpaka) describe as the originator of intelligence, being directed by a wise being (*satpuruṣa*) and

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which alone is the primal cause (bīja) of all knowns (vyakta), I venerate that Invisible God as well as that Science of Calculation with Unknowns... Since questions can scarcely be solved without the reasoning of algebra, not at all by those of dull perceptions I shall speak, therefore, of the operations of analysis." Thus, according to Bhāskara II, algebra may be defined as the science which treats numbers expressed by means of symbols, and in which there is scope and primary need for intelligent artifices and ingenious devices.

Origin of Algebra in India

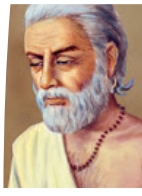
The origin of algebra in India can be traced back to the period of the *Sulba* (800–500 B.C.) and the *Brāhmaṇa* (2000 B.C.). But it was then mostly geometrical. The geometrical method of the transformation of a square into a rectangle having a given side, which is described in the important *Sulba* is obviously equivalent to the solution of a linear equation in one unknown, viz., $ax = c^{2n}$. The quadratic equation has its counterpart in the construction of a figure (an altar) similar to a given one but differing in area from it by a specified amount. The usual method of solving that problem was to increase the unit of measure of the linear dimensions of the figure.

Āryabhaṭṭa I also made important contributions in Binomial expansion. These were used to find operations on indices, square, square-root, cube, cube-root, etc.

Trigonometry

Apart from developing the concepts of Algebra, Indians also worked on systematically developing the concepts of Trigonometry that resembled its modern form. They used algebra in its further development.

Although the Greeks founded trigonometry, their progress was halted due to the absence of adequate algebraic machinery and notations. Indians invented the sine and cosine functions, discovered most of the standard formulae and identities, including the basic formula for $\sin(A \pm B)$ and constructed fairly accurate sine tables. Brahmagupta (A.D. 628) and Govindaswami (A.D. 880) gave interpolation formulae for calculating the sines of intermediate angles from sine tables—these are special cases of the Newton-Stirling and Newton-Gauss formulae for second-order difference (which are studied in advanced classes). Remarkable approximations are given in Indian texts including 3.1416 of Āryabhaṭa I (A.D. 499), 3.14159265359 of Mādhava (A.D. 1500) and 355/113 of Nīlakaṇṭha (A.D. 1500).



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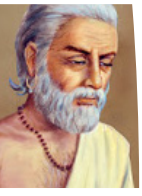

Āryabhaṭa I, for the first time defined a right triangle within a quarter-circle and expressed perpendicular and base as function of angle, and expressed perpendicular, jyā or jīva as R Sinθ, and base, *ko-jyā* as R Cosθ, satisfying the relation $(R \sin \theta)^2 + (R \cos \theta)^2 = R^2$, where R is the radius of the circle. He gave the values, R Sin 0° = 0, R Sin 30° = R/$\sqrt{3}$, R Sin 45° = R/$\sqrt{2}$, R Sin 60° = R$\sqrt{3}$/2, R Sin 90° = R.

He further suggested that the Sine values increase in the interval $0 \leq \theta \leq 1$, and Cosine values decrease in the same way, i.e., R Cos0° = R and Cos90° = 0. All these facts are studied in modern day Trigonometry also.

Exercise

1. How many fundamental operations were known to the ancient mathematicians? What are they?
2. Name the Ancient Indian Mathematicians and their period, who worked in Geometry and Trigonometry.
   Do you find any similarity between the ancient mathematical concepts and the present day mathematical concepts of Algebra, Geometry, and Trigonometry that you study? (You may also refer the literature given in the references).
3. (a) Do you think there is any difference in the process of performing the basic operations on numbers in the earlier period and the present system which you studied?
   (b) Which process do you feel easier? Why? Discuss with your friends.
4. Write at least three terms used by ancient mathematicians and give their meanings:
   (a) addition
   (b) subtraction
   (c) multiplication
   (d) division
5. Find from the literature the concepts in mathematics other than those discussed in this chapter developed by the Indian mathematicians.

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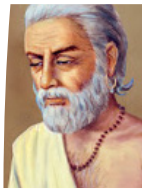

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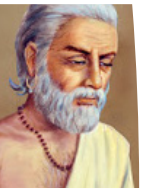

Glossary

Gaṇita anuyoga: the exposition of the principles of mathematics

Kapaṭa-sandhi: a method of multiplying numbers

Saṁkhyāna: the science of numbers, meaning, arithmetic and astronomy

Sulbasūtra: The Sanskrit name *Sulbasūtra* or 'Sulva Sūtra' derives from the practice of the surveyors of marking out straight lines close to the ground with cords joined by pegs. We still see bricklayers practising this art, if they want to be sure enough that the wall is straight.

Yajurveda Saṁhitā: The *Yajurveda-Saṁhitās* are the prayer-books for the *Adhvaryu* priest who had to do practically all the ritualistic works in a sacrifice.

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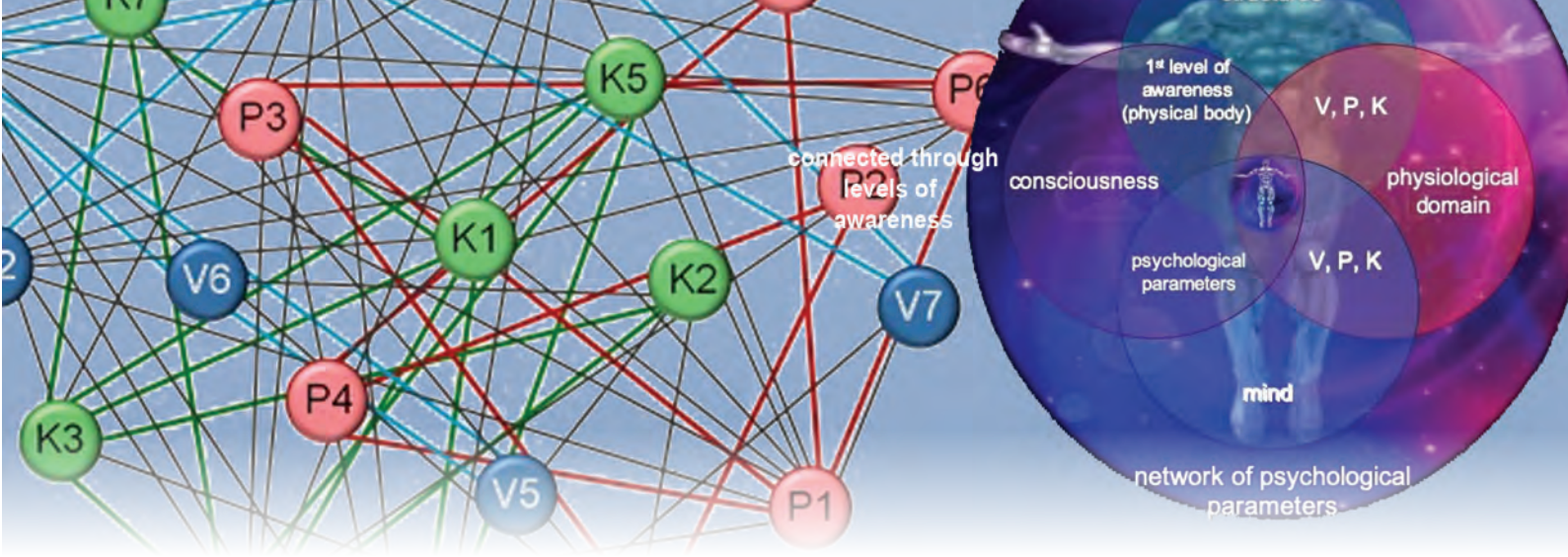

Introducing *Āyurveda*
The Science of Health and Disease

7

Welcome to the science of *Āyurveda*, a truly holistic health system encompassing all aspects of well-being—from physical, physiological and psychological to environmental and ecological health. Literally meaning 'science of life', *Āyurveda* is a vast treasure house of interesting and contemporarily relevant scientific concepts dealing with health and diseases. It is a science which helps optimise one's health enabling a healthy, productive, happy and satisfactory lifespan. While *Āyurveda* emphasises greatly on preventive and promotive health, its comprehensive approach to treatment is in tune with the increasing interest in systemic approach to disease in modern medicine. The world is waking to the vast clinical expertise and wisdom of *Āyurveda*. Let us rediscover this in India too.

A Brief History of *Āyurveda*—Origins Lost in the Mists of Antiquity

For a very long time, having been the main system of healthcare in India, the beginning of *Āyurveda* is lost in the mists of antiquity. Suffice it to say that codified *Āyurveda* would be at least 4000 years old or 1500 years prior to Hippocrates, the father of Western medicine. *Āyurveda* has its roots in the *Vedas*, considered the oldest written-down literature in the world from which many theories and philosophies have sprung. The systematised science of *Āyurveda* has resulted from the amalgamation and practical application of these various concepts and doctrines.

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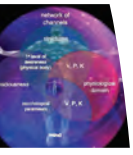

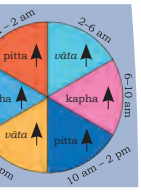

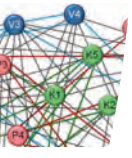

Oldest healthcare system in the world

Ayurvedic principles of healthy living were effortlessly incorporated into day-to-day practices.

Āyurveda's history and development is closely interwoven with the history and culture of the Indian sub-continent to the extent that ayurvedic thoughts and methods have had a very deep impact on the lifestyle of its people. In practically every household, there was (and still is) an awareness of ayurvedic treatment for common ailments. For example, adding pepper and turmeric (*haldī*) in hot milk for common cold and cough is very much based on *Āyurveda*. These are reflected not only in the traditional use of spices and medicinal ingredients in the cuisine but also in the daily activities and religious rituals. *Āyurveda* has had a pervasive influence on the daily life of Indians and continues to do so, and therefore is the longest unbroken health tradition in the world.

Āyurveda, a common science for all biological systems

Ancient *ṛṣis* studied nature for its underlying patterns and on the basis of this approach, *Āyurveda* has accepted the hypothesis that there are common principles underlying all the microcosms (all living entities) and macrocosm (universe). According to this hypothesis, humans, animals, plants and the universe are composed of the same basic elements and follow the same physical laws. Therefore, *Āyurveda* deals with *manuṣya* (human), *mṛga* (animals) and *vṛkṣa* (plant science or botany) with the same fundamental principles applying to all of them. Ancient Indians gave equal importance to the health of humans, animals and plants alike.

Literature in *Āyurveda*

The ancient ayurvedic physicians were not only astute observers but were keen documenters as well. They had documented their clinical observations and inferences meticulously. In all three branches of *Āyurveda*, namely human (*manuṣya*), plant (*vṛkṣa*) and animal (*mṛga*), a large body of knowledge has been preserved in texts, written not only by the ayurvedic practitioners of yore but also the later-day physicians indicating the continuity of this indigenous medical system. Names of some of the books are given below to give an idea of the extensive documentation done from the days of yore.

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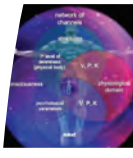
Manuṣya Āyurveda

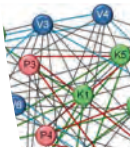
As is evident from the table, rich medical literature was produced by the ayurvedic physicians of ancient period continuously consolidating and validating the knowledge based on millenia of astute clinical observations, documentation and logical inference. Today, as healthcare stakeholders are searching for comprehensive understanding of health and disease management, *Āyurveda* with its systematic documentation is again in the spotlight.

Table 1: Some important literature on Manuśya Āyurveda

Books and authors	Some interesting details
Written in B.C.E.	
Atreya Saṁhitā by Atreya	46,500 verses and 5 *adhyayas* (chapters)
Agniveṣa *Tantra* by Agniveṣa, a disciple of Atreya; this text is now known as *Caraka Saṁhitā* after the redactor Caraka	Focuses on internal medicine and elaborates on the fundamental principles and management of health and diseases in *Āyurveda*; translated into Arabic, Latin, Persian, Chinese, Tibetan, Mongolian and Khotanese; over 43 commentaries have been written
Suśruta Saṁhitā by Suśruta	Deals with surgery, anatomy and the topics of contemporary interest such as cataract and reconstructive surgery
Nimi Tantra by Nimi	Focuses on ophthalmology and surgical interventions
Harita Saṁhitā by Harita, disciple of Atreya	On general medicine
Bhela Saṁhitā by Bhela; disciple of Atreya	Explains brain and mind, and discusses blood circulation
Kaśyapa Saṁhitā by Kaśyapa	Only 78 of the 200 chapters are available now; the only currently available ayurvedic text focusing on pediatrics, mother and child care; female doctors are mentioned
Dhanvantari Saṁhitā, Cikitsā Tattva Vijñāna, Cikitsārpaṇam, Cikitsā Darśana, Cikitsā Kaumudī by Divodāsa Dhanvantari	The author established University of Kāshi; teacher of *Suśruta* and *Nimi*

Did you know?
Caraka Saṁhitā is the recording of the proceedings of a conference on *Āyurveda*, which took place at the foothills of Himalayas and chaired by the famous ayurvedic physician Atreya. It was attended by ayurvedic doctors from across the world. Their names are mentioned in the very first chapter of the text.





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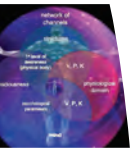

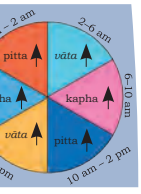

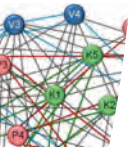

Vaidya Sandeha Bhañjana and *Janaka Tantra* by Janaka	Books not available now
Kumāra Tantra by Rāvana, *Parvataka Tantra, Bandhaka Tantra, Hiranyākṣa Tantra*	Other books on paediatrics
Vaidyaka Sarvasvam, Aśva (horse) *Śāstra* and *Nakula Samhita* by Nakula	Books not available now
Vyādhi Sindhu Vimardana and *Gavā* (cow) *ayurveda* by Sahadeva	Books not available now
Written in C.E.	
Aṣṭāṅga Saṁgraha and *Aṣṭāṅga Hṛdaya* by Vāgbhaṭṭa	Concise compilation of all ayurvedic knowledge available then and also updated information on new plants and diseases
Śāraṅgadhara Saṁhitā by Śārangadhārācārya	Has 3 divisions and 32 chapters; a concise treatise to help ayurvedic clinical practice; mentions pulse (*nādi*) diagnosis and elaborates on preparation of medicines
Mādhava Nidhān by Mādhava	Best compilation of the cause and development of diseases, their symptoms and the associated complications for easy understanding and diagnosis of diseases
Bhāva Prakaśa (Bhāva Miśra)	80 chapters and 10268 verses; a systematic compilation of available information on plants and herbs used in medicinal preparations

Vṛkṣa (Botany) and *Mṛga* (Veterinary) *Āyurveda*

Vṛkṣa Āyurveda explains the life-cycle of plants in addition to prevention and treatment of plant diseases. It discusses, among many other things, the origin of plant from seed, different parts of plants, their structure, functions and diseases afflicting them, rules of plantation, seasons ideal for plantation and harvesting, and ideal agricultural practices. Examples of the books on ayurvedic botany are *Kṛṣi Parāśara* by *Parāśara* and *Vṛkṣa Āyurveda* by Surapālā.

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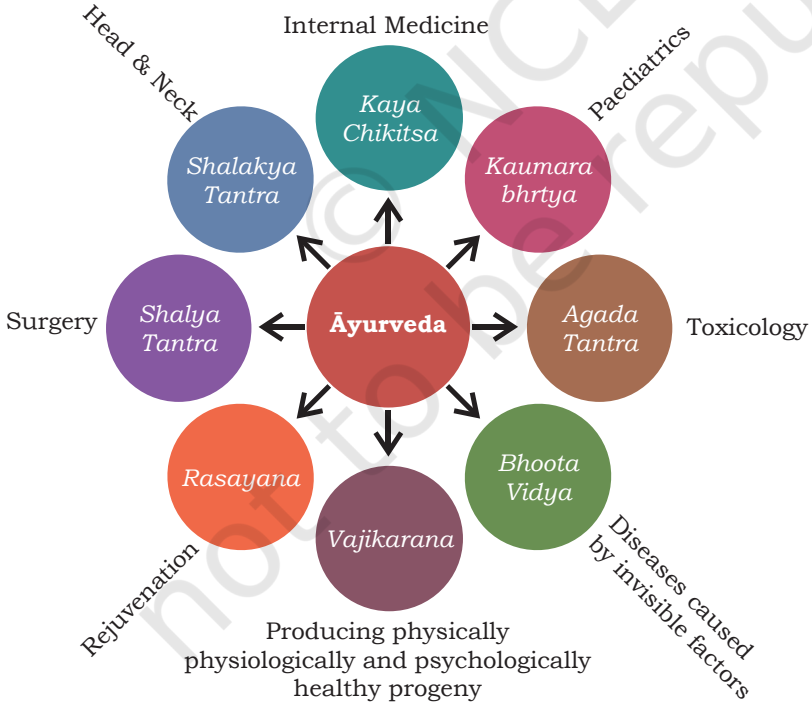
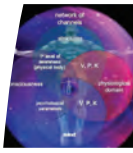
Śālihotra, father of Veterinary *Āyurveda*, wrote *Haya Āyurveda* (translated into Persian Arabic, Tibetan and English), *Śālihotra Saṁhitā* a very early Indian treatise on veterinary medicine, *Aśvapraśna Śāstram, Aśvalakṣaṇa Śāstram* and *Aśva Āyurveda.* Pālakāpya wrote on *Hasti Āyurveda* and *Gaja Śāstram.* With this background information on the extensive literature in *Āyurveda*, let us move onto the science of *Āyurveda*, which has eight clinical specialities (*Aṣṭāṅga Āyurveda*).

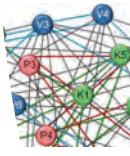
Role of Basic Sciences in Medicine

All medical systems are applied sciences, which have adopted and adapted concepts and theories from basic sciences. For example, modern medicine has used many hypotheses, methods and tools of physics and chemistry for its next step in understanding and managing health and disease. Similarly, the theories and concepts which have influenced *āyurveda* have their basis in 'darśana', the fundamental and codified disciplines of Indian knowledge systems. It is interesting to note that the literal meaning of *darśana* and theory (derived from the Greek word 'theoria') are similar, namely, to 'view or observe'.



From the time of inception, Āyurveda has recognised eight clinical specialities. Kaumārabhṛtya includes today's discipline of Obstetrics and Gynaecology





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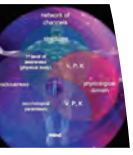

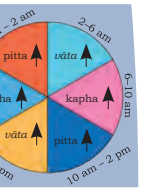

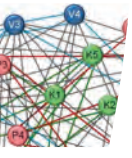

Western medicine—role of physics

Physics, one of the most fundamental scientific disciplines, studies energy, matter and laws of nature. This subject has had a profound effect on the study of living systems. Its contribution to discovery of instruments (e.g., microscope, X-ray and other imaging techniques) is well known. But physics has also contributed in a more fundamental and theoretical way. The worldview or understanding of reality put forth by classical (also called Newtonian) physics has played a substantial role in the understanding of living systems and hence modern medicine. The other technical developments in physics has helped catalyse and develop them further.

> By nineteenth century, understanding of the world based on Newton's physics emerged. It considered the world as being made up of building blocks of atoms and molecules.

A Newtonian mechanistic worldview considers the world as being made up of building blocks of atoms and molecules. This became the platform from which human body was viewed and understood. Consequently, modern medicine started regarding the body as made up of building blocks and as a sum of individual parts. In this predominantly structural hierarchical viewpoint, atom is at the lowest level forming the basic building block of the human body. Atoms make molecules, which in turn progressively form cells, tissues, organs and organ systems such as skeletal, endocrine and reproductive and so on. This is called a reductionist perspective since the entire human system is reduced to the fundamental unit of matter for both understanding and management. Reductionism means breaking down of a complex system into smaller parts and studying them separately.

Life is understood in terms of its chemical constituents, and diseases are understood and treated from a structural and chemical perspective. However, there is now a slowly changing perception that the structural and chemical components do not remain in isolation but are in dynamic relationships, which decide the overall functioning of the cells, organs and the organism itself. Western medicine is now striving for an integrated approach to manage health and disease.

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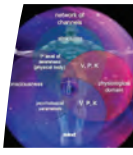
Āyurveda—role of *darśanas*

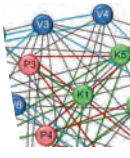
The worldview of Indian Knowledge Systems is that of interconnectedness, where nature exists as a continuum—the universe is a dynamic web of interconnected and inseparable entities in a dynamic relationship.

Just as Western medicine has adopted concepts from basic sciences, the theories and concepts which have influenced *āyurveda* have their basis in *darśana*, the fundamental and codified disciplines of Indian knowledge systems. The *darśanas* which have contributed to the development of *Āyurveda* are *Vaiśesika*, *Nyāya*, *Pūrva Mīmāṁsā*, *Sāṅkhya*, Yoga and *Uttara Mīmāṁsā/ Vedānta*. Some of the theories and concepts from *darśanas* incorporated and used in Āyurveda deal with physical and non-physical realities, creation of universe, life and matter, constituents of physical matter (concept of *anu* or atom as the fundamental particles of the physical world in *Vaiśeṣikadarśana*), mind-body-consciousness relationship, 'tridoṣa' (*vāta, pitta, kapha*), *pañcamahābhūtas* (fundamental elements), transformation of substances to form new products, concepts of calculation and measurements (time, weight and length), and methodologies for scientific study and analysis.

Āyurveda is, in fact, a melting pot of a number of disciplines, a proof that knowledge was not compartmentalised in ancient India. *Āyurveda* is associated with and draws not only from *darśana* but from other wide-ranging subjects. For example, *vṛkṣa and mṛga āyurveda*, metallurgy (for surgical instruments), civil engineering and architecture (construction of hospitals and pharmacies), chemistry (*Rasa Śāstra*), astronomy, ethics, water management, mathematics (calculations, units of measurements, weights and measures, concept of time, etc.), culinary science, pharmacology, diet, nutrition and agriculture.

All these form the basic sciences that have given rise to *Āyurveda*'s theoretical framework, under which it has put together an enormous body of observational data accumulated and documented through centuries (Table 1). Using these, *Āyurveda* has developed its own methodologies to diagnose and treat diseases. These well developed theories and practices form the backbone of ayurvedic approach to health and disease. *Āyurveda*'s unbroken chain of experience indicates that its theories and therapies have been tested by thousands of physicians on millions of patients and have stood the test of time.





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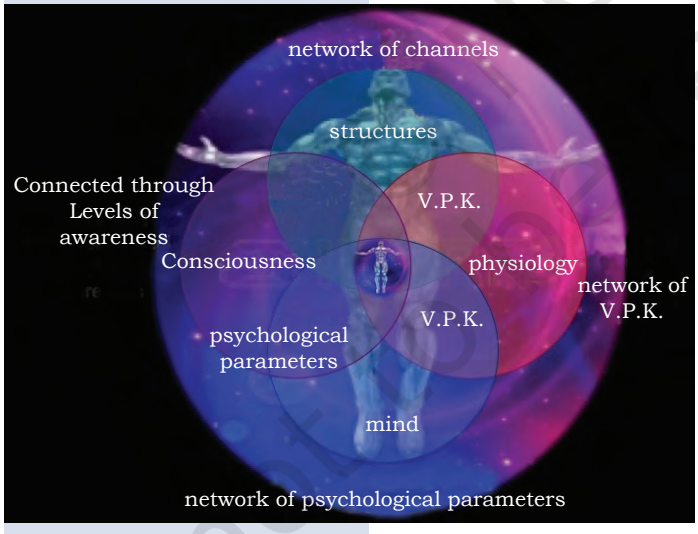
Understanding of Human System in *Āyurveda*

You all may wonder if there could be another way to understand the human system, other than that of Western medicine. The human body being a very complex biological entity provides a wide scope for multiple perspectives. Classification and categorisation makes it easy to handle complex systems and we know the classification adopted by Western medicine. It is a structure based classification based on Newtonian physics' viewpoint of the nature of reality. Similarly, the Vedic worldview of interconnectedness between everything in the universe is reflected in the way the human system is understood in *Āyurveda*.

Āyurveda considers four domains in the human system, which are connected within (intra-connected) and also with each other (inter connected). These are the structural (networked through various physical channels or *srotas* such as blood vessels and nerves), physiological (networked through biophysical properties defined by *vāta*, *pitta* and *kapha* known as *tridoṣa*), psychological (intra-connected by psychological parameters called *mānasikadoṣa*), and the subtlest domain of consciousness (intra connected by the levels of awareness defined by *pañcakoṣa*). The entire human system is thus one connected seamless entity in *Āyurveda* with even the subtlest domain of awareness connected to the gross physical structural domain by the first level of awareness, which is the physical body. The connectedness also extends to environment, world and even cosmic reality.



Humans conceptualised as a seamless indivisible whole with four intra- and inter-connected domains: structural, physiological, psychological, consciousness. V - vāta, P - pitta, K - kapha.

The core idea of the human system as an interconnected entity, and not merely a structure made of atoms and molecules, is unique to *Āyurveda* and gives it an enormous advantage in dealing with the human system in a holistic way. *Āyurveda* also recognises the importance of the mechanical aspects of human body, this can be inferred from the well developed branch of surgery in those days. *Suśruta*, the ayurvedic surgeon is acknowledged even by present day surgeons for his surgical procedures of rhinoplasty and otoplasty. Yet, *Āyurveda* is based on principles that go beyond the purely mechanical view, i.e., a vision of wholeness, functional interdependence and integration.

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The hypothesis of interrelatedness finds practical expression in *Āyurveda* through a number of concepts, theories and parameters, which are beyond the scope of this chapter to be elaborated. However, some of these concepts are—*pañcamahābhūta* (fundamental elements of the physical world), *srotas* (channels connecting the entire human system at the gross and subtle levels), *ojas* (responsible for overall vitality, energy, immunity and strength), *tridoṣa* (physico-physiological factors), *sapta dhātu* (structural components of the body), *trimala* (by-products of metabolism), *triguṇa* (components of the mind and consciousness), *agni* (entity responsible for all digestive and metabolic processes), *prakṛti* (bio-psychological constitution) and the tenet that common principles underlie the microcosm (individual) and macrocosm (universe).

Systems Approach of *Āyurveda* to Health

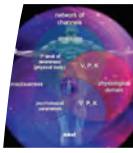
Although, a number of theories are used in *Āyurveda*, the theory of *tridoṣa* [*Vāta (V), Pitta (P) and Kapha (K)*] is fundamental to its understanding and practical management of health and disease. *Āyurveda*'s approach is predominantly functional. For the functional classification, *Āyurveda* has identified three functions, namely, movement (*Vāta*), metabolism and transformation (*Pitta*), and growth and support (*Kapha*).

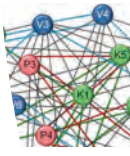
What do we mean by *vāta*, *pitta* and *kapha*?

In addition to functions, VPK includes parameters which are biophysical, chemical and physiological in nature. There are ten pairs of opposing properties (*Viṁśatiguṇa*) mentioned in *Āyurveda*:

(i) cold (*śītа*) and hot (*uṣṇa*);
(ii) heavy (*guru*) and light (*laghu*);
(iii) slow/dull (*manda*) and sharp (*tīkṣṇa*);
(iv) oiliness (*snigdha*) and dryness (*rukṣa*);
(v) immobility (*sthira*) and mobility (*sara*);
(vi) soft (*mṛdu*) and hard (*kaṭhina*);
(vii) smooth (*ślakṣṇa*) and rough (*khara*);
(viii) adhesive/sticky (*picchila*) and non-slimy/non-adhesive (*viśada*);
(ix) viscidity (*sāndra*) and diffusivity/fluidity (*drava*);
(x) minuteness (*sūkṣma*) and gross (*sthūla*).

These 20 properties, at the opposite ends of a continuum, characterise material bodies and are used in *Āyurveda* to understand them. These properties refer not only to the biophysical properties of the substances but also their effect on the body. For instance, heavy substances are considered





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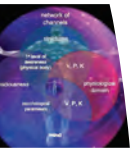
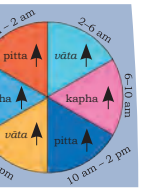
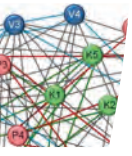






Network of the system properties associated with Vāta (V), Pitta (P) and Kapha (K). The circles correspond to nodes representing the system properties and the lines between nodes refer to the association between properties. Parameters associated with V (V1-V7), P (P1-P7) and K (K1-K7) are coloured differently. The intra-connections are shown in thicker lines with the colour of the corresponding category. The inter-connections are shown by dark grey lines. V1 - dryness; V2 - temperature (cold); V3 - mobility; V4 - weight (light); V5 - roughness; V6 - non-adhesive; V7 - minuteness; P1 - temperature (heat) ; P2 - penetrative power; P3 - fluidity; P4 - pH; P5 - acrid; P6 - causing movement; P7 - lubrication (mild); K1 - stability; K2 - smoothness; K3 - lubrication; K4 - viscosity; K5 - temperature (cold); K6 - weight (heavy); K7 - adhesion.

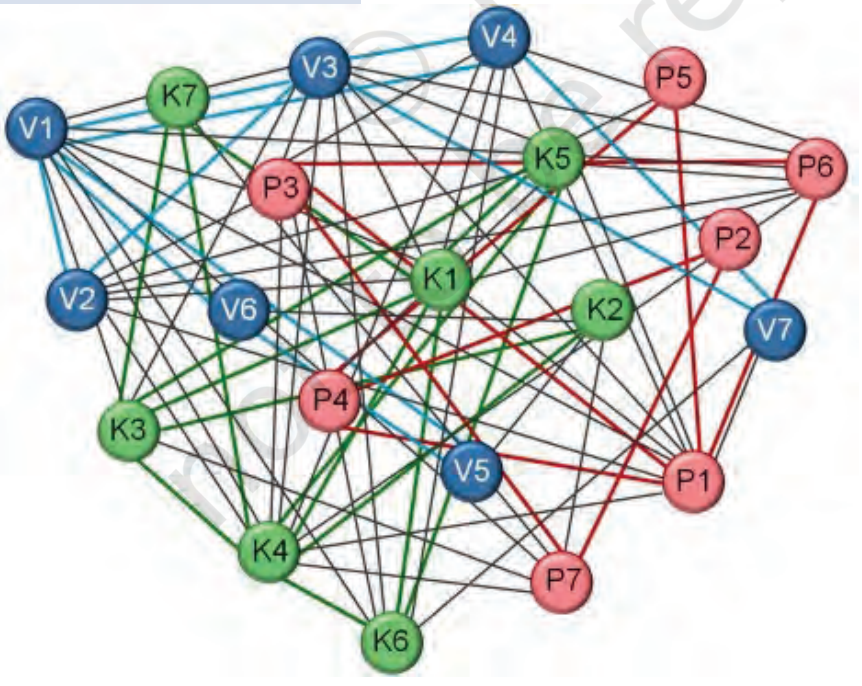
difficult to digest and hot materials are understood to produce heat in the body. All the parameters under V, P and K are intra and inter-connected forming a network. The key to health is the stability of these factors in the network. Disease is considered a perturbation of this network.

Translation of the theory of VPK to clinical use

Āyurveda has incorporated the theory of VPK in an interesting way to all the factors which have a role in health and disease. Dietary ingredients, plants, physical and mental activities, seasons and clinical symptoms, all of which have a role in health, disease and treatment are classified and explained in terms of V, P and K. For example, wheat (dietary ingredient) increases K; exercise (activity) increases V; autumn (season) increases P; skin disorder (clinical manifestation)—dryness indicates involvement of V, *Pitta* involvement when there is reddishness and burning sensation, and K in case of pruritus and exudation. VPK thus provides a theoretical framework within which all clinical symptoms can be classified and understood. No clinical symptoms lie outside this VPK classification.

Regimens used for health management

Concepts like *dinacaryā* (daily regimen) and *ṛtucaryā* (seasonal regimen) provide strategies for empowering people to take charge of their health. These deal with the biological rhythms, which are natural cycle of changes in our body's functions in coordination with the clock of nature as in circadian (24 hour) and circa-annual (1 year periodicity) rhythms. Both these regimens offer methods for preventive and promotive health by taking care of the nature induced changes in the functions and parameters defined under V, P and K. By following the do's and don'ts of these regimens, one can have healthy and productive days and also prevent seasonal diseases.



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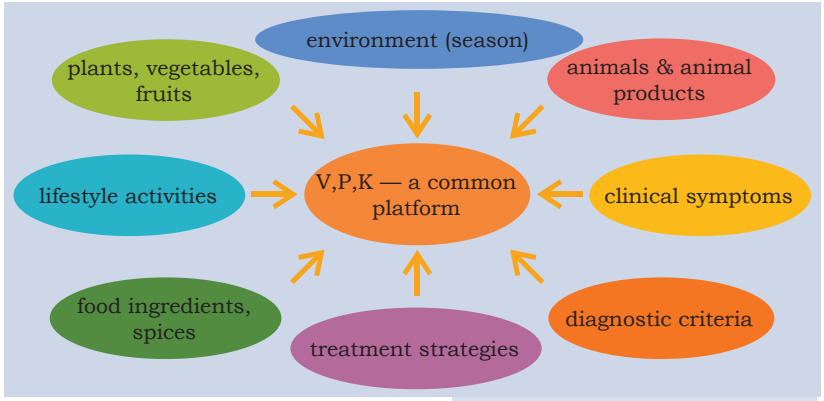
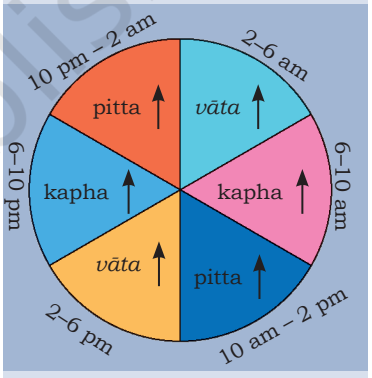
Comprehensive Approach of *Āyurveda* to Disease Management



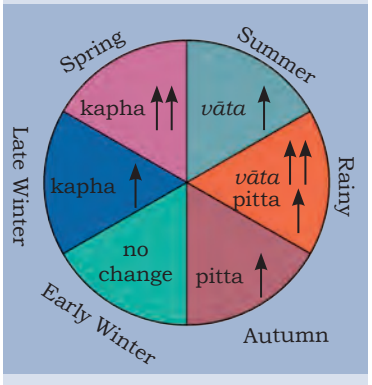
Vāta, Pitta and Kapha provide a common platform for all the factors which play a role in health and disease. Adapted and reprinted from Ref (28) with permission from the Journal Editor.

Health is considered as the balanced interplay between the various functions and parameters whereas disease is understood as a perturbation in V,P,K and hence a functional failure. Because of this, *Āyurveda* looks beyond the behaviour of individual structures and addresses the biophysical and system properties in an effort to rebalance the system. *Ayurvedic* treatment aims at restoration of the functional balance. The increase or decrease of V,P,K is accompanied by symptoms, which are described in detail in *ayurvedic* texts. For example, wet cough and cold indicate increase of *kapha*. One can infer the state of V,P,K from the symptoms and take corrective measures to bring them back to equilibrium state. This is accomplished by avoiding *kapha* aggravating diet and activities and using medicines made with *kapha* reducing medicinal plants. In addition, care is taken during seasons and times of the day when *kapha* increases.

We have already seen that V,P,K is a common platform for all the health related factors and also clinical symptoms. From a clinical viewpoint therefore, it provides a common interface facilitating easy conversion of all diagnostically and therapeutically relevant parameters enabling a VPK-based diagnosis and treatment. The *ayurvedic* therapeutic strategy is, therefore, different but comprehensive, addressing all causative factors and incorporating all the therapeutically relevant parameters such as medicines, diet and activities. The causative factors include biotic or living (e.g., plants, animals and micro-organisms) and abiotic or non-living (e.g., sunlight, temperature, wind, rain, etc.) components of the environment.



(a)



(b)

Effect of (a) circadian and (b) circa-annual (seasonal) rhythm on vāta, pitta and kapha.

Āyurvedic Approach to Diet and Nutrition

Hippocrates said "Let food be your medicine and medicine be thy food". *Āyurveda*, which predates Hippocrates declares the same and goes further to say 'you are what you eat'. The current dismal health scenario and the growing realisation of the importance of diet and lifestyle activities in health reinforces these statements. *Āyurveda* categorically states

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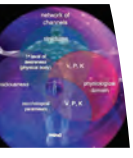

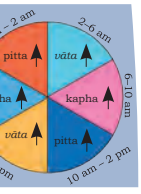

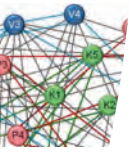

that improper diet and activities are the causative factors for most diseases and play a vital role in maintenance of health and prevention of diseases.

A balanced diet in *Āyurveda* is one which helps to maintain the equilibrium of VPK and which should include all the six tastes, namely sweet, sour, salt, pungent, bitter and astringent. *Āyurveda* uses functional indices (how the food is functionally relevant to the person) rather than calories to assess nutrition. A number of parameters of practical significance are used to understand the functional, nutritional and therapeutic attributes of food and the ingredients that make it up, e.g., taste, thermogenic (producing heat or burning more calories) property, digestibility of the food, digestive power of the diner, etc. *Āyurveda* also stresses the importance of eating right. Some of the questions it answers are—who can eat what (personalised nutrition), what to eat, how much to eat, when to eat, how to eat (meal plan) and when to eat what (eating seasonally). *Āyurveda* has an in-depth knowledge of the nutritional and therapeutic values of daily foods such as rice, wheat, milk, ghee, oil, vegetables, fruits and spices. All food items and ingredients are classified in terms of taste and VPK.

Traditional Indian cooking is based on the time-tested ayurvedic principles. Ingredients like ginger, pepper, turmeric and fenugreek are used not for flavour but for their medicinal properties. Incorporating such spices for cooking dishes with flavour and taste to suit the different climatic conditions and seasons has been the strength of Indian cuisine. Bitter and astringent tastes although beneficial to health, are generally not favoured by dieters due to their unpalatability. Traditional Indian cuisine offers several recipes to increase the palatability of bitter and astringent food substances by cooking or seasoning them with spices and other ingredients which can mask these tastes and at the same time retain their health benefits.

Therapeutic but tasty multi-ingredient foods were designed by incorporating antidotes for ingredients with side effects. For example, the side effects of chilli and pungent spices are tempered by cooking them in oil or ghee while retaining their medicinal properties. Another example is the preparation of wheat halwa—the K increasing property of wheat is countered by cooking in the K pacifier ghee. Ingredients like saffron (*Crocus sativus*) and cardamom (*Elettaria cardamomum*), while reducing K also flavours the sweet dish. Saffron and cardamom, in addition to their antidote role also contribute other medicinal attributes to the halwa. Over centuries, numerous recipes have been

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developed across the country taking into account factors such as regional variations in climate, season, vegetation, culture and occupation of people. In depth analysis about the effect of one dietary ingredient on another in Indian cuisine is beyond the scope of this chapter. However, the examples outlined provide sufficient basis to understand how the curative ability of food was in-built in its culinary processing.

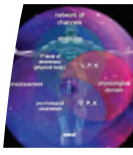
Āyurvedic Pharmacology

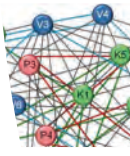
Āyurveda has its own pharmacological parameters to understand, explain and put to therapeutic use the medicinal plants. Other sources of medicines in *Āyurveda* are animals, metals and minerals. The concept of *rasa* (generally taken to represent taste as a sensory perception) plays an important role in ayurvedic pharmacology (*Dravyaguṇa Vijñāna)*. *Āyurveda* has categorised plants under six types of *rasa*—*madhura* (sweet), *amla* (sour), *lavaṇa* (salty), *kaṭu* (hot), *tikta* (bitter) and *kaṣāyā* (astringent). Each plant or plant part can have one or a combination of *rasas*. Together with other biophysical and physico-chemical properties (*guṇa*) and pharmacological potency (*vīrya*), the knowledge of *rasa* of plants, predicts nearly 80% of the pharmacological action from an ayurvedic perspective.

Āyurveda uses plant parts in entirety to extract a group of compounds and not single molecules or active principles as in allopathic medicine—for example, water soluble (polar) compounds such as polyphenols, tannins and carbohydrates are extracted in decoction (*Kaṣāya/kvatha*); polar and non-polar compounds like phytoalcohols and terpenes in alcoholic preparations (*ariṣṭa, āsava*); non-polar compounds such as alkaloids and glycosides in lipid based preparations (*ghṛtam, tailam*). The other major difference in the medicinal use of plants between *Āyurveda* and modern medicine is that ayurvedic medicines are mostly multi ingredient formulations and also provides therapeutic nutrition. The therapeutic attributes of ayurvedic medicines probably lies in the combinatorial synergistic effect of the ingredients.

Āyurveda and Evolving Concepts in Western Medicine

Western medicine is slowly moving away from its conventional reductionistic and disease-centric approach towards a more inclusive vision of the human system. There is a growing realisation of the role of factors such as diet, nutrition and mind in health and disease. Some of these new concepts with counterparts in *Āyurveda* are discussed in brief.





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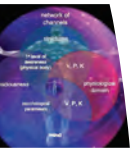
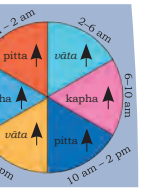
Systems biology

This new exciting and upcoming field talks of interactions between the components of abiological system, in particular cells and how these interactions give rise to new properties and functions. An example is how the inflammable hydrogen atom combines with oxygen to give rise to water molecule, with fire extinguishing properties. This emerging field explains and uses how information from lower levels (e.g., atoms) limits understanding the complexity of the higher levels (e.g., molecules). It is pertinent to note that *Āyurveda* talks of how interactions between system properties affect the functioning of the biological system.



Personalised medicine

Western medicine is realising that individual variations in the population limits similar responses to standard treatments. New concepts such as pharmacogenomics, nutrigenomics, etc., which takes into account the genetic variations in the population are being explored to help customise the treatment strategies. *Āyurveda* uses the concept of *prakṛti* (bio-psychological constitution) for personalisation of both preventive health and treatment.

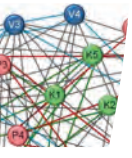


Therapeutic nutrition

Although food as medicine is not a new concept, modern medicine's focus on disease management had delinked it from this old notion. However, with emerging knowledge of the role and importance of food in many diseases, therapeutic nutrition is beginning to be taken very seriously. The question is how to use food and nutrition not only to boost the body's natural ability to heal but also for preventive and complementary therapy. These concepts are inbuilt into ayurvedic approach to health and disease. It is also pointed out that ayurvedic medicines are also designed for providing therapeutic nutrition.

Circadian rhythm

The 2017 Nobel Prize in Medicine was awarded to elucidation of the molecular mechanisms controlling circadian rhythm. The work showed that there are internal clocks synchronising cellular metabolism and biological rhythms with 24 hour periodicity. This work has brought to the fore the importance of circadian rhythm and its role in health and disease. *Āyurveda*, with its knowledge on circadian and circa-annual rhythms induced changes in VPK shows the translation of this information in management of health and disease.



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Ecological health and disease prevention

Environment is no more viewed as a separate, unconnected domain. Its relationship with individuals and public health are becoming apparent. Ecological health and disease prevention is gaining much attention these days. *Āyurveda* considers humans as part of nature and connected to it, and hence impact of ecological health on individual and public health is dealt with in detail in *Āyurveda*.

Sustainable medicine

The aim of sustainable medicine is in ensuring the long-term viability of the medical system, so that high-quality medical services remain available for the health needs of future generations. With spiralling cost of Western medicine, sustainability of the system is gaining increasing attention. Sustainability is at the core of *Āyurveda*, as it spells out its concern about natural resources and emphasises the importance of their harmonious use for human needs. It has provided solutions through its concept of sustainability, low-energy consuming lifestyle and food habits, and preventive health.

Āyurveda—Contemporary Scenario

The following timeline traces very select and interesting milestones in *Āyurveda* from nineteenth century onwards.

1827 — Ayurvedic course started in Govt. Sanskrit College, Calcutta

1833 — Discontinuation of the above mentioned course by the British

1920 — Indian National Congress resolve to accept āyurveda as India's National Health Care System

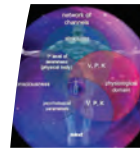
1921 — Āyurveda and Unani Tibbia College established in Karol Bagh, Delhi

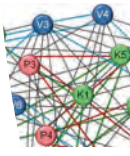
1927 — Āyurveda college established in Banaras Hindu University

1970 — Indian Medicine Central Council Act, 1970 introduced for regulation of practice and uniform standards of education.

1995 — Dept of Indian Systems of Medicine and Homoeopathy (ISM&H) created in the Ministry of Health and Family Welfare, Govt. of India.

2005 — ISM&H renamed as AYUSH (Āyurveda, *Yoga* and Naturopathy, *Unani*, *Siddha* and *Homoeopathy).*





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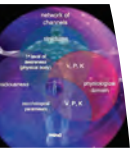
2008 — Creation of North East Institute of *Āyurveda* and Homeopathy at Shillong.

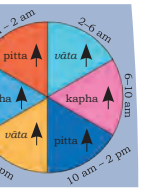
2010 — Creation of Pharmacopoeia Commission of Indian Medicines (PCIM) an independent body under the Dept. of AYUSH.

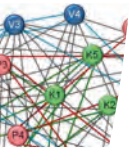
2011 — Publication of Ayurvedic Pharmacopoeia of India Part-I, Vol. VIII, containing the quality standards of water and hydro-alcoholic extracts of Ayurvedic drugs. (A major development over the traditional method of using herbs).

2014 — Department of AYUSH upgraded to Ministry of AYUSH

Among all the systems in AYUSH, *Āyurveda* holds a prominent position. There are more than 250 ayurvedic colleges offering a professional graduate level medical degree in BAMS (Bachelor of Ayurvedic Medicine and Surgery)/*Āyurvedacārya* in India. This 5½ years' course (akin to MBBS) is taken after Class XII with science subjects. Post-graduation in *Āyurveda* (MD) is of three years duration and is offered in select colleges and institutions.







Contemporary Importance of *Āyurveda*

As the world faces increasing chronic, psychosomatic, stress and lifestyle related disorders such as diabetes, cancer, and cardiovascular diseases, *Āyurveda* with its unique perspective, holistic approach, knowledgeable emphasis on diet and lifestyle activities, and time-tested clinical practices, have a crucial role to play. As a health care system, it can empower the individual with a healthy and productive life. *Āyurveda* should not be seen merely as a reminder of a past glory but as an example of Indian knowledge system with contemporary and increasing relevance in present day healthcare and disease-care. Its vast clinical experience and expertise, accumulated and documented over several millennia, should be utilised to benefit the people.

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Exercises

1. Explain about the *manuṣya* and *mṛga Āyurveda*.
2. What are the eight branches of *Āyurveda*?
3. Explain the role of *Vāta*, *Pitta* and *Kapha* in maintenance of biological cycle.
4. Name the Ayurvedic surgeon who is also acknowledged in modern surgery.
5. What is *tridoṣa* theory?
6. What are the Ayurvedic approaches for diet and nutrition?
7. Name some Ayurvedic texts written in B.C. and A.D.

Activities and Projects

1. Identify medicinal plants in your school.
2. Identify medicinal plants in your neighbourhood.
3. Find out the Sanskrit names of some common medicinal plants.
4. Gather information from your house elders about the medicinally important ingredients used for cooking in your house.
5. Work out the role of each ingredient in any of the traditional preparation (for example pickles) from an ayurvedic point of view.
6. Find out your prakṛti.
7. Collect same plants from different regions and study their differences.
8. Find out which of the ancient ayurvedic textbooks are still available and where.

Suggested Readings

Ayurvedic Pharmacopoeia of India, Ministry of AYUSH, Govt. of India.

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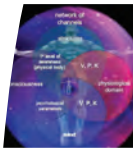

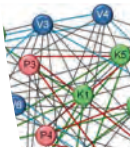

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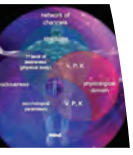

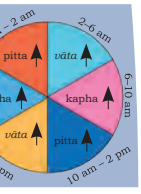

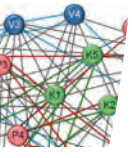

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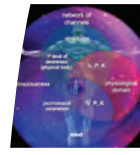

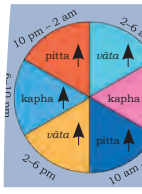

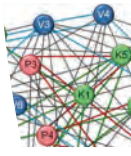

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Glossary

Āyurvedacharya: A graduate level medical degree awarded after completion of an undergraduate programme (BAMS) in Āyurveda.

BAMS: Bachelor of Ayurvedic Medicine and Surgery

Circadian rhythm: The internal clocks that synchronise cellular metabolism and generate biological rhythms with 24 hours periodicity.

Circa-annual rhythm: biological process in living creatures with approximately one year periodicity in sync with the seasons in nature.

***Darshana*:** a Sanskrit word literally meaning 'to view or observe'. In the context of ancient Indian literature, it refers to the fundamental and codified disciplines of Indian knowledge systems.

Manushya Āyurveda: *Āyurveda* dealing with humans.

Mṛga Āyurveda: *Āyurveda* dealing with animals.

Non-polar compounds: Compounds not soluble in water like fats and oil.

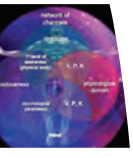
Polar compounds: Water soluble compounds such as polyphenols, tannins and carbohydrates, etc.

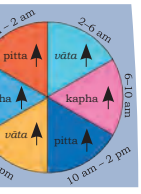
***Rasa*:** a Sanskrit word literally meaning 'juice or essence'. In the context of ayurvedic pharmacology, it is generally taken to represent taste as a chemosensory perception.

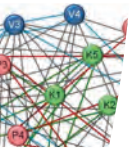
Rishi: a Sanskrit term for an accomplished and enlightened person.

***Tridosha*:** Refers to *Vāta, Pitta and Kapha*, concepts fundamental to Āyurveda's understanding and practical management of health and disease. They are defined by certain physiological functions and grouped under them are a set of biophysical, chemical and physiological parameters which impact these functions defined by each of the *tridoshas.*

***Vṛkṣa Āyurveda*:** *Āyurveda* dealing with plants







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Chemistry and Metallurgy in India

8

From Alchemy to Chemistry

Modern chemistry, as we learn it today, evolved from Alchemy and Iatrochemistry during 1300–1600 C.E. Alchemy initially developed in ancient Egypt as a result of their belief in life after death due to which they developed mummification procedures. When Alexander the Great conquered Egypt and Greeks reached Egypt, the Greek philosophers became interested in Egyptian ways. They merged their knowledge about matter with the Egyptian science. In the seventeenth century, Arabs occupied Egypt and named the Egyptian science as *al-Khemia* which is now seen as a possible origin of the word alchemy. The Greek word *Khumos* has been suggested as an alternate origin for the word alchemy. The alchemy was introduced to Europeans by Arabs who brought it to Spain from where it spread to the rest of Europe. Modern chemistry took shape in eighteenth century in Europe after a few centuries of alchemical traditions. It developed from Alchemy and Iatrochemistry as a result of search for two interesting things:

1. Philosopher's stone (*Paras*) which would convert all base metals, e.g., iron and copper into gold.
2. 'Elixir of life' which would grant immortality.

Alchemy led to the discovery of amalgams and advances in many other chemical processes and the apparatus required for them. By the sixteenth century, alchemists in Europe had separated into two groups. One group focused on discovery of new compounds and their reactions and the branch of science, now named as chemistry, evolved. The

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other group continued to look into spiritual and metaphysical side of alchemy continuing the search of immortality and transmutation of base metal into gold. India and China had their own alchemical traditions.

Archaeological findings of Harappa and Saraswati sites provide ample proof in favour of advanced knowledge in the field of agriculture, irrigation, architecture and production of metals. The hymns of *Yajurveda* and *Ṛgveda* are unsurpassable proof of the antiquity of India's progress in science. These *Vedas* mention the extraction and processing of metals such as gold, silver, copper, tin, lead, iron and their alloys.

In ancient India, chemistry had various names i.e., *Rasāyana Śāstra, Rasatantra, Rasakriyā* or *Rasavidyā.* It included metallurgy, medicine, manufacture of cosmetics, glass, dyes, inks, etc. Ancient Indians applied that knowledge of chemistry in various walks of life.

Baked bricks
Source: *History Textbook, Our Pasts–I,* Class VI, NCERT

Early Chemical Techniques, Technology and Arts

The Indus Valley Civilisation or Harrapan civilisation spreads across in India extensively. It spread from Alamgirpur in western Uttar Pradesh (in the East) to Sutkagendor in Makaran and Bhagatrav in South Gujarat (in the West) and from Gumla and Ropar (in the North) to Daimabad in Maharastra (in the South). Indus Valley Civilisation is known for its technological knowledge in variety of fields. Indus Valley people used a number of minerals for a variety of purposes. Archaeological findings show that baked bricks were used in the construction work. Gypsum cement has been used in the construction work in which lime, sand and traces of $CaCO_3$ have been found.

Archaeological evidences show the mass production of pottery in Indus Valley Civilisation or the Harappan culture, which can be regarded as the earliest chemical process in which materials were mixed, moulded and subjected to fire to achieve desirable qualities. Remains of glazed pottery have been found in Mohenjodaro. Many useful products from the excavation sites are plasters, medical preparations, hair wash products, etc.

Harappans made faience, which is glazed with ceramic. It was used in ornaments. Indus Valley faience was stronger because it was made from partially melted quartz. Although from Egypt or Mesopotamia, faience was produced from easily

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प्राचीन काल में धातु विज्ञान का वर्णन उल्लेखित है -

जरतीभिरोषधीभिः पर्णेभिः शकुनानाम् ।
कार्मारो अश्मभिर्द्युभिर्हिरण्यवन्तमिच्छतीन्द्रायेन्दो परिस्रव॥

ऋग्वेदः- 9/112/2

अर्थात् कामार यानी की लोहार तालपत्र में लकड़ी के टुकड़े और लोहे के खनिज के पत्थर को आकन्द वृक्ष के पत्तों से ढ़ककर तपाता है तथा प्राप्त इस्पात धन संपन्न व्यक्ति को बेचने के लिए प्रतीक्षा करता है।

अश्मा च मे मृत्तिका च मे गिरयश्च मे पर्वताश्च मे सिकताश्च मे वनस्पतयश्च मे हिरण्यं च मेऽयश्च मे श्यामं च मे लोहं च मे सीसं च मे त्रपु च मे यज्ञेन कल्पन्ताम् ।। यजुर्वेद संहिता – 18/13

अर्थात् सभी प्रकार के पाषाण, विविध प्रकार की मृत्तिकायें, पहाड़ से होने वाले भस्म, चूर्ण आदि, पर्वतों से प्राप्त रत्नादि योग्यपदार्थ, बालुकायें, वनस्पतियाँ, सुवर्ण, लौह अयस्क, लोहित श्याम लौह, लाल लौह, सीसा तथा टीन राँगा ये सब धातुयें हमें यज्ञ से प्राप्त हों।

available material, a highly specialised technical expertise was needed to process them in finished goods. Efforts of Jonathan Mark Kenoyer to find out the secret of glazing technique show that artisans partially melted powdered rock quartz in high temperature kilns using flux additives made of plant ash. A glassy frit was obtained which was reground into a fine paste and subjected to firing again at around 940 degree celsius to obtain dense glazed faience. His efforts indicated that artisans had mastery over controlling the kiln temperatures.

Different Areas of Development in Ancient India

The major chemical arts and crafts in early period were pottery, jewellery making, dying of cloths, tanning of leather, glass making, etc. Several evidences are available in favour of these in literature and many have been obtained from archaeological excavations.

A number of statements and materials described in the ancient Vedic literature can be shown to agree with the modern scientific findings. Copper utensils, iron, gold, silver ornaments and terracotta discs and painted grey pottery have been found in many archaeological sites in North India. The golden gloss of the northern black polished ware could not be replicated and is still a technological mystery. In the following paragraphs you will learn about some of the areas of development in ancient India.

Glazed pottery

Source: National Museum, New Delhi

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Glass Making

Literary Sources

Suśruta Saṁhiṭa: This mentions about different instruments made of glass crystals and quartz, used in the absence of other instruments. It also mentions about beautiful glass vessels, employed for serving food. Therefore, it can be concluded that by the sixth century B.C.E., glass vessels were manufactured for domestic and other utilitarian purposes.

Arthaśāstra of Kauṭilya: According to this book, advance licence fee was imposed for starting glass industry, which was payable in advance like modern surety money. This proves the existence of flourishing glass industry during the Mauryan epoch. It also mentions the use of different kinds of metallic salts and oxides for encrusting the valuable glass.

Foreign Travellers' Account

Pliny: His narration about Indian glass industry tells that metallic salts and oxides were used for colouring crystals and the Indian glass industry was superior to those of other countries.

Some of the important conclusions that can be drawn from the close scrutiny of available literary sources are:

- The antiquity of glass can be traced back to the period from 800 to 500 B.C.E.
- The glass ornaments were deemed costly and made with remarkable skill. Imitational skills of craftsmen were highly advanced and they could imitate other costly ornaments of jewels, gold, silver or gems.
- Different varieties of glasses were not only manufactured but also exported to other countries. The glass making industry had avenues in the commercial world.

Archaeological Evidences

A number of glass objects have been found in Maski in South India (1000–900 B.C.E.) and Hastinapur and Taxila (1000–200 B.C.E.) in North India. Glass and glazes were coloured by addition of colouring agents like metal oxides.

According to Jonathan Mark Kenoyer, first evidence for glass beads production at Harappa comes around 1700 B.C.E., which is 200 years before glasses were being made in Egypt.

Archaeological excavations gave evidence of the occurrence of glass from fairly large number of ancient sites. Some of these are Rupar, Alamgirpur, Hastinapur, Maski and sites at Madras district.

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From the cumulative evidence of archaeology and literature, it can be legitimately inferred that glass manufacturing had started in India in the first quarter of the first millennium B.C.E.

Explain how various available evidences help in establishing that Indians manufactured glass in ancient time.

Paints and Dyes

Varāhamihira's Bṛhatsaṁhitā is a sort of encyclopaedia, which was composed in the sixth century C.E. It informs about the preparation of glutinous material to be applied on walls and roofs of houses and temples. It was prepared entirely from extracts of various plants, fruits, seeds and barks which were concentrated by boiling and then treated with various resins. It will be interesting to test such materials scientifically and assess them for use. The paintings found on the walls of Ajanta and Ellora, which look fresh even after ages, testify to a high level of science achieved in ancient India.

A number of classical texts like Atharvaveda (1000 B.C.E.) mention some dye stuffs; the materials used were turmeric, sunflower, madder, orpiment, cochineal, lac and kermes. Some other substances having tinting property were *Kamplcica, Pattanga* and *Jatuka.* According to *Ṛgveda*, tanning of leather and dying of cotton were also practiced during the period 1000–400 B.C.E.

Perfumes and Cosmetics

It appears that the whole range of modern cosmetics was conceived by ancient Indians and material required was obtained from the natural resources then available.

Varāhamihira's *Bṛhatsaṁhitā* gives references to perfumes and cosmetics. Recipes for hair dyeing were made from plants like indigo and minerals like iron powder, black iron or steel and acidic extracts of sour rice gruel.

Gandhayukti describes recipes for making scents, mouth perfumes, bath powders, incense and talcum powder.

Aṣṭāṅga Hridaya, a 1500 year old book of *Āyurveda*, describes six different formulations to be used in the six seasons of the year for body beautification.

Lot of efforts were taken by ancient researchers to evolve the science of cosmetics. Raja Serfoji who ruled (1788 C.E.–1832 C.E.) in Thanjavur in Tamil Nadu established an institute of medical research called Dhanvantari Mahal and

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a great library called Serfoji's Saraswati Mahal at Tanjore. Experiments were conducted in Dhanwantari Mahal. He selected a few thousand efficacious recipes after testing them. They were then given to Tamil pundits to be woven into verse in Colloquial Marathi for the benefit of Marathi speaking people. These recipes are called *Anubhoga Vaidya Bhāga*, which means 'recipe tested by experience'. Many ancient families of Tanjore still possess medicines prepared in the Dhanvantari Mahal, bearing the original seals indicating the sample and the date of its preparation. Raja Serfoji developed a herbarium in his palace which supplied plants to Dhanvantari Mahal for experimentation. He got the paintings of these plants prepared and bound in the book form for future reference.

- With what purpose Raja Serfoji established Dhanvantari Mahal and Saraswati Mahal?
- What arrangement did Raja Serfoji make for dissemination of research work carried out in his institute of medical research?

Chemicals in Ancient India

Suśruta Saṁhitā explains the importance of alkalies. The *Caraka Saṁhitā* mentions about ancient Indians who knew how to prepare sulphuric acid and nitric acid; oxides of copper tin and zinc; sulphates of copper, zinc and iron; and the carbonates of lead and iron.

Rasopaniṣada describes the preparation of gun powder mixture. Tamil texts also describe the preparation of fireworks using sulphur, charcoal, saltpetre (i.e., potassium nitrate), mercury, camphor, etc.

Kautilya's *Arthaśāstra* describes the production of salt from sea. Nagarjuna's work *Rasratnākara* deals with the formulation of mercury compounds. He was a great Indian scientist. He was a reputed chemist, alchemist, and metallurgist. He has discussed methods for the extraction of metals like gold, silver, tin and copper.

Cakrapāṇi discovered mercury sulphide. The credit for inventing soap goes to him. He used mustard oil and some alkalies as ingredients for making soap. Indians began making soaps in eighteenth C.E., oil of eranda and seeds of mahua plant and calcium carbonate were used for making soap.

A book *Rasārṇavam* appeared around 800 C.E. It discusses the usage of various furnaces, ovens and crucibles for different purposes. It describes methods by which metals could be identified by flame colour.

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Paper and Ink Making

Collecting evidences for researching into the history of paper making is difficult as paper is easily destroyed by environment or fungal or insect attack. Very few ancient specimens have survived in the protective environment of *Stūpas* or libraries. In eastern India, manuscript evidence begins from the twelfth century. The earliest evidence of paper manuscripts, probably of Indian origin, with Indian scripts are those that have survived in the stupas of Kuchar in central Asia and in Gilgit in the Karakoram. On palaeographic evidence, these manuscripts have been dated to be of fifth and eight century C.E. According to the account of Chinese traveller I-tsing, paper was known to India in seventh century. A paper manuscript belonging to 1105 C.E. is at the Ashutosh Museum of Calcutta. There are three known accounts of the use of paper in India by travellers who visited India between fifteenth and seventeenth centuries. These three accounts indicate that paper was used in India not only as writing material but also for wrapping common wares and it also seems to be a well known article of export from India.

An ink pot has been obtained in the excavations at Taxila that indicate that ink was used in India from fourth century. Colours of ink were made from chalk, red lead and minium (i.e., *Sindoor*). The recipe for making ink is given in *Rasaratnākara* of Nityanatha. The black ink made from nuts and myrobalans was durable and kept in water in iron pots. It was used in Malabar and other parts of the country. Special ink made from roasted rice, lamp black, sugar and juice of plant kesurte has been used in Jain manuscripts. It seems that in late mediaeval period, Indians knew that tannin solution becomes dark blue-black or greenish by addition of ferric salts. They used this knowledge to make ink.

How can one establish that paper and ink were made in ancient India?

Alcoholic Liquors

It seems that the process of fermentation was well known to Indians. *Vedas* and Kauṭilya's *Arthaśāstra* mention about many types of liquors. *Caraka Saṁhitā* also mentions ingredients such as barks of plants, stem, flowers, leaves, woods, cereals, fruits and sugarcane for making *Āsavas.*

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Āyurvedic Medical System

In the *Atharvaveda*, plants and vegetables have been recognised as helpful agents for the treatment of diseases. Two great works of Āyurveda period are *Caraka Saṁhitā* and *Suśruta Saṁhitā,* Caraka is older than Suśruta. *Suśruta* is a treatise on surgery and *Caraka* is a treatise on medicine. The texts on Indian alchemy (*rasavidyā*) reveal that a wide variety of inorganic and organic substances were used in the treatment of diseases. Mercury is a metal which has been of great alchemical importance in ancient India. Mercury was passed through 18 processes before it could be used for treatment.

Knowledge of Fundamental Concepts of Chemistry

Concept of Atom

The concept, that matter is ultimately made of indivisible building blocks, appeared in India a few centuries back as a part of philosophical speculations. *Acārya Kanda* born in 600 B.C.E., originally known by the name *Kaśyapa* was the first profounder of the 'atomic theory'. He formulated the theory of very small indivisible particles which he named '*Anu*' (comparable to molecules). He authored the text '*Vaiśeṣika Sūtras*'. According to him all substances are aggregated form of smaller units called atoms (*Paramāṇu*), which are eternal, indestructible, spherical, suprasensible and in motion at the primordial state. He explained that this individual entity cannot be sensed through any human organ. Kaṇāda also added that there are varieties of atoms that are as different as the different classes of substances. He said these could form pairs or triplets (*aṇu*), among other combinations, and unseen forces caused interaction between them. He conceptualised this theory around 2500 years before John Dalton (1766–1844). John Dalton presented his atomic theory which was a turning point in the study of matter.

Nano particles

The concept of reduction of particle size of metals is clearly discussed in *Caraka Saṁhitā*. Extreme reduction of particle size is now termed as nanotechnology. Nanotechnology and nano science is the study and use of structures between 1 and 100 nanometre size. The 'nanoscale' is typically measured in nanometres, i.e., billionths of a metre. The manipulation and manufacture of materials and devices on the scale of atoms or small groups of atoms is done in this technology.

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It can be applied across all the other science fields, such as chemistry, biology, physics, materials science, engineering and medical science. Nanostructures interact with the body at molecular level. Bioavailability of a drug is improved in nano form and the effect of drug toxicity is reduced. *Caraka Saṁhitā* describes the use of *bhasma* of metals in treatment for ailments. It has been proved that the *bhasmas* have nano particles of metals. The scientists in ancient times performed the process of continuous burning and cooling of metals, minerals or gems (in some cases more than 100 times) and mixed with these herbs and other medicinal substances to get rid of toxic effects of these substances. It may be a chance discovery and they may have limited knowledge that the processing changed the physical and chemical properties of the substance i.e., metal, mineral or gem, but the drugs prepared by them were more effective, had quick action and were required in smaller doses. The drugs became more palatable and also had more shelf life. There is urgent need to carry out scientific research to analyse the risk-benefit aspect of these herbo-mineral or metal based medicines.

After the decline of alchemy, Iatrochemistry reached a steady state, but it declined due to the introduction and practice of western medicine in the twentieth century. During this period of stagnation, pharmaceutical industry based on *Ayurveda* continued to exist, but it too gradually declined. It took about 100–150 years for Indians to learn and adopt new techniques. During this time, the foreign products poured in. As a result, indigenous traditional techniques gradually declined.

Modern science appeared on Indian scene in later part of the nineteenth century. By the mid nineteenth century, European scientists started coming to India and modern chemistry started growing up. Modern metallurgy had exponential growth after Industrial Revolution.

Metallurgy in India

For over 7000 years, India has had a high tradition of metallurgical skills. The two important sources for the history of Indian metallurgy are archaeological excavations and literary evidences. The first evidence of metal in Indian subcontinent comes from Mehrgarh in Baluchistan, where a small copper bead was dated to about 6000 B.C.E. It is, however, thought to be native copper, which has not been extracted from ore. Archaeological excavations have shown that Harappan metalsmiths obtained copper ore from Aravalli Hills, Baluchistan or beyond. Many bronze figurines of humans and animals have been unearthed from Harappan sites.

The Dancing Girl
(Made of bronze, Mohenjodaro)
Source: National Museum, New Delhi

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Systematic excavations at Mohenjodaro in Sindh and Harappa in Punjab show that during the mature Harappan period, the metal workers perfected the metallurgical skill. Harrapans used metals like tin, arsenic, lead, antimony, etc., for alloying. They had also perfected the wax technique of metal casting in as early as the third millennium B.C.E. They melted and forged a variety of objects from metals such as lead, silver, gold and copper. They improved the hardness of copper for making artefacts by using tin and arsenic.

Copper

Copper metallurgy in India dates back to the beginning of Chalcolithic culture in the sub-continent. Copper and bronze were used for making weapons, tools and cheaper ornaments. Copper found at Mohenjodaro contains an appreciable amount of lead and also some objects made of copper which also contain nickel. An alloy of copper and arsenic was also used at Mohenjodaro. Copper was smelted from ore and afterwards refined in clay crucible. The fragment of such crucible with slag sticking at the edges has been found at the excavation of Mohenjodaro.

One of the resource zones for copper was Aravalli range. There are deposits of copper, lead, silver and zinc ores in the Aravalli hills. The copper ore of this region contains 4 per cent to 8 per cent arsenic. Many copper objects obtained from Harappa and Mohenjodaro contains high level of arsenic. This suggests that metal workers of Harappan civilisation obtained copper ore from this region of Aravalli hills. In Rajasthan, the copper mining areas are along the eastern flank of Aravalli hills extending from Bharatpur, Alwar and Khetri region in North East to the South of Udaipur.

There are evidences of deep mining in the Rajpur Dariba in the district Udaipur.

Radiocarbon dating shows that the mines are of the last quarter of the second millennium B.C.E. Large heaps of broken stones have been found near the mining area. It seems that ore bearing rocks were taken to the valley, where they were roasted, crushed, concentrated and smelted.

Now, archaeological and analytical data are available to prove that the objects excavated from later Chalcolithic sites were made in India. A number of axes, chisels and mirrors have been unearthed by archaeological excavations in pre-Harappan settlement sites—Nal, Mehi, and Kot Diji. A chemical analysis of a fragment of an axe from Nal shows that it is made up of 94% pure copper with 5% of nickel in it. This shows that smelters and smiths of the Indian subcontinent, who made these articles, had advanced

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knowledge of copper metallurgy. In an excavation in 1962, at chalcolithic site at Ahar near Udaipur in Aravalli Hills, heaps of semi fused glass-like material together with copper tools and quartz in stratified layers were unearthed. Radiocarbon dating of the material shows it to be of the period from 1800 to 1600 B.C.E. Analysis of the glass-like material showed it to be copper metallurgical slag which is the waste product of the copper smelting industry. It establishes the evidence of copper smelting activity in Ahar during Chalcolithic period. More than fifty such sites have been located and some of these are Gilund, Meroli, Kumaria and Kadukota. This also shows that the Indian chalcolithic metal objects were, most probably, indigenously made. Extensive copper ore deposits are located in the Aravalli Hills within the area inhabited by Chalcolithic communities. Aravalli copper ore deposits can, therefore, be considered as the source likely used by the Chalcolithic metal workers. Though chalcopyrite ore is abundant in Aravalli Hills, the percentage of copper is poor in the ore but the percentage of copper in many examined samples was found to be 98 per cent. This purity in copper is equivalent to the purity of present time blister copper. Evidence of ore dressing, roasting, fluxing and extraction of copper consistently in 98 per cent purity prove that advanced stage of metallurgical processes was reached and maintained in Chalcolithic period.

There is fairly extensive evidence for ancient mining of copper ores from Khetri region of Rajasthan in north-western India dating to about the third–second millennium B.C.

Iron

Recent excavations in the central parts of Ganges Valley and Vindhya Hills have shown that the art of iron smelting and manufacturing of iron artefacts was well known in eastern Vindhyas and it was in use in the Central Ganga Plain. In the recent excavations conducted by Uttar Pradesh State Archeological Department, iron furnaces, artefacts, tuyers and layers of slag have been obtained. Radiocarbon dating places them between 1800 and 1000 B.C.E. The quantity and types of iron artefacts and the level of technical advancements in India indicate that the introduction of iron work took place even earlier.

Asur Munda and Agaria tribes of India have been the main tribes concerned with the manufacture of iron. Agaria tribe practiced iron smelting on large scale. This tribe has been living in Andhra Pradesh, Madhya Pradesh, Eastern Uttar Pradesh, Bihar and Orissa. The ancient practice was considered to be extinct till 1963, when Ghose of TISCO

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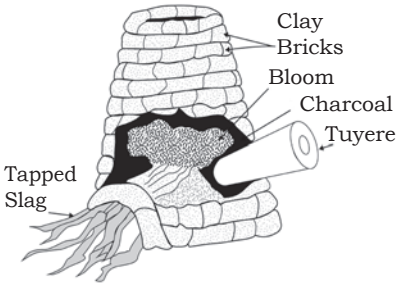


Ancient iron making furnace, Naikund (700 BCE)

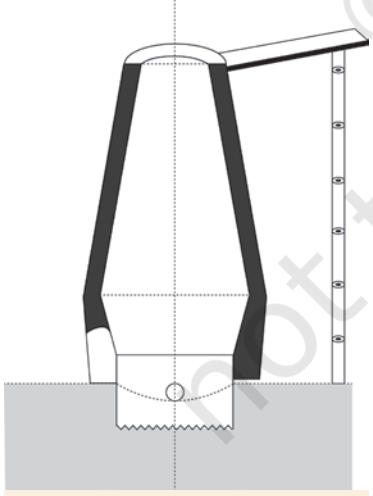
located the tribsman at Kamarjoda, Chiglabecha and Jiragora, who could construct their traditional furnace and operate them to produce wrought iron bloom.

These furnaces were meticulously designed and constructed using pre-shaped curved clay bricks. The refractory clay used in the bricks was obtained from the places close to the site of operation.

The design criteria such as shaft taper, bosh to top diameter and bosh angle in these primitive furnaces have been found to be almost same as in modern blast furnaces of 1960–70. The ancient furnaces have relatively large hearth diameter because these produced semi-solid sponge iron and liquid slag instead of molten cast iron and slag because forging operation is not possible on cast iron due to brittleness.

Iron smelting and the use of iron was especially established in South Indian megalithic cultures. The forging of wrought iron seems to have been at peak in India in the first millennium C.E. Greek accounts report the manufacture of steel in India by crucible process. In this process, iron, charcoal and glass were mixed together in a crucible and heated until the iron melted and absorbed the carbon. With the passage of time, blacksmiths of ancient India gained specialised skills in the hot and cold working and hot and cold forge welding. They gained experience about the effect of carbon on the physical properties of iron. They developed the process of carburisation. This resulted in hardening of the material. This process has been known as 'steeling'. This was used for making arrow heads, swords and knives, etc. *Suśruta* (500 B.C.E.) has also described this procedure and heat treatment for making of the surgical knives having such sharp edges that could bisect human hair longitudinally.

India was a major innovator in the production of advanced quality steel. Indian steel was called 'the wonder material of the Orient'. A Roman historian, Quintus Curtius, records that one of the gifts that Porus of Taxila (326 B.C.E.) gave to Alexander the Great, was some two-and-a-half tons of Wootz steel. Wootz steel is primarily iron containing a high proportion of carbon (1.0 – 1.9%). Wootz is the English version of word *'ukku'* which is used in the language in Karnataka and Andhra Pradesh for steel. Literary accounts suggest that Indian Wootz steel from southern part of Indian subcontinent was exported to Europe, China and Arab World. It became prominent in Middle East where it was named as Damascus steel. Michael Faraday tried to duplicate this steel by alloying iron with a variety of metals including noble metals, but failed.



Schematic diagram showing inner contours of Agaria iron making furnace

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When iron ore is reduced by charcoal in solid state, it forms porous iron blocks. Therefore, reduced iron blocks are also called sponge iron blocks. Any useful product can only be obtained from this material after removing the porosity by hot forging. The iron so obtained is termed as wrought iron. The process control achieved by the ancient iron smelters was so high that they could produce 6–10 tons of wrought iron of almost uniform quality used for the manufacture of objects like the world famous Iron Pillar at Delhi.

Iron Pillar, Qutub Minar Complex, Delhi

Source: *History Textbook*, Class VI, NCERT

Engraved Sanskrit inscription suggests that it was brought here from elsewhere in the Gupta period. The average composition of the components present in the wrought iron of the pillar besides iron are 0.15% C, 0.05% Si, 0.05% Mn, 0.25% P, 0.005% Ni, 0.03% Cu and 0.02% N. The most significant aspect of pillar is that there is no sign of corrosion in spite of the fact that it has been exposed to the atmosphere for about 1,600 years. High purity of the metal (> 99 per cent) and presence only of traces of injurious elements, and clean environment prevented it from rusting. Also most recently, Balasubramaniam has explained that a composite layer of iron hydrogen phosphate formed on the pillar prevents it from rusting. Rapid industrialisation and the increase in traffic in and around Delhi is raising the sulphurous gases in the environment. If this remains uncontrolled, corrosion may occur and weaken the matrix of the pillar. Another famous iron pillar is located at Mookambika temple in Kodachari Hill in a town near Mangalore. It also belongs to the same period. The iron beams lying in the Surya temple at Konark are still bigger in size. Non corroding iron beams were being used extensively in the construction of temples in Orissa dating back to the sixth and thirteenth centuries C.E.

Evidences of iron smelting are available in North East region also. Radiocarbon dating of charcoal from the iron slag obtained in this region provides evidence of continuous smelting in Khasi Hills. Meghalaya is the earliest iron smelting site studied in the entire region of North East India. The slag layer, which is dated to 2040±80 years BP (253 B.C.E.–A.D. 128) is the remnant of former iron ore excavation and iron manufacturing visible even now in the landscape of Khasi Hills.

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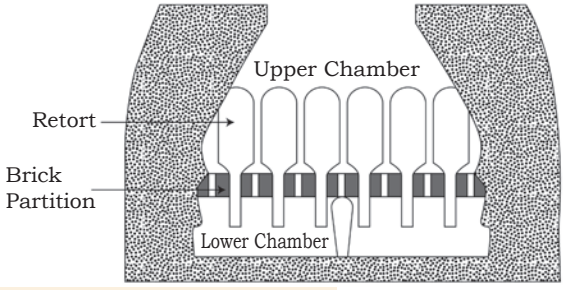

Zinc retorts from Zawar zinc mines

Zinc

There is archaeological evidence of zinc production in Rajasthan at Zawar around the sixth or fifth B.C.E. Due to low boiling point, zinc tends to vaporise while its ore is smelted. As a result, its vapours present in the furnace are reoxidised and the metal is lost. Therefore, zinc is produced by distillation technique. India was the first country to master zinc distillation. The technique used for distillation in Zawar was designed for downward distillation in which vapours were condensed in a lower container. The distillation of the pallets of roasted ore mixed with charcoal powder, salt, etc., and borax as flux was carried out in brinjal shaped retorts. In excavation at Zawar, these retorts have been found. Each distillation unit had two chambers. Lower chamber was separated from the upper chamber by perforated bricks. Charged retorts were fixed in the perforations with their mouth projecting out in the lower chamber. The mouth of the retort was sealed and fixed in the collecting earthen pots. Earthen pots were kept in the lower chamber of the distillation unit. Earthen pots were dipped in a water trough for cooling the vapours of zinc coming out of the retort. Upper part of the retort was heated by making fire in the upper chamber. Zinc vapours coming in the earthen pot cooled inside it due to cold water surrounding the earthen pot. This technique was also applied to mercury. Indian metallurgists were masters in this technique. This has been described in the Sanskrit texts of fourteenth century.

Gold and Silver

Harappans also used gold and silver as well as their joint alloy electrum. Variety of ornaments such as pendants, bangles, beads, rings, etc., have been found in ceramic or bronze pots. Early gold and silver ornaments have been found from Indus Valley sites such as Mohenjodaro (3000 B.C.E). These are on display in the National Museum, New Delhi. India has the distinction that the deepest ancient mines in the world for gold are in Maski region of Karnataka with carbon dating from mid first millennium B.C.E. A sample of silver containing Ag 94.5; Pb 0.42; Cu 3.68; insoluble 0.38 per cent was found in Mohenjodaro. The process of extracting silver was known to the people of Mohenjodaro.

Hymns of *Ṛgveda* gave earliest indirect references to the alluvial placer gold deposits (i.e., deposits of gold minerals formed in stream) in India. The river Sindhu was an important source of gold in ancient times. It is interesting

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that the availability of alluvial placer gold in the river Sindhu has been reported in modern times also. It has been reported that there are even now, great mines of gold in the region of Mansarovar and in Thokjalyug. The *pāli* text *Aṅguttara Nikāya* narrates the process of the recovery of gold dust or particles from alluvial placer gold deposits. Although evidence of gold refining is available in vedic texts, it was Kauṭilya *Arthaśāstra*, authored probably in third or fourth century B.C.E., during Mauryan era, which has much data on the prevailing chemical practices in a long section on mines and minerals including metal ores of gold, silver, copper, lead, tin and iron. Kauṭilyas' *Arthaśāstra* describes a variety of gold called *rasviddhā*, which is naturally occurring gold solution, Kalidas also mentioned about such solutions. It is astonishing how people recognised such solutions.

The native gold (i.e., gold found in nature) has different colours depending upon the nature and amount of impurity present. It may be that the different colours of native gold were a major driving force for the development of gold refining.

Disappearance of Metallurgical Skills

India's prosperity was drastically harmed in the period of Turkish invasion. Turkish rulers carried away the country's riches to Islamic countries and enslaved men, women as well as artisans. In Mughal period, surviving artisans in the remote places of the country were patronised and were resettled in new places. Under the Mughal patronage, the iron workers of Gujarat and Deccan began making forged iron guns and fire arms as well as a variety of war weapons and armours.

Cottage iron making was flourishing by the end of nineteenth and early twentieth century. The iron production was taking shape of an organised industry. In 1852, Oldham had reported working of 70 iron making furnaces in Birbhum district. These large furnaces could produce 2 tonnes of iron per furnace at the cost of ₹17 only. However, these industries could not last long. The British representatives took over the local industries. Inspite of the better quality of Indian iron and steel, they began to import British and Swedish iron and levy heavy tax on local produce. European and British governments established their own industries. In order to supply raw material to these industries, British government began exporting high grade iron ore from India and banned iron and steel-making in India. The British government also began to import finished iron and steel machinery and levied high taxes on the Indian produce. Thus the tribal art of iron and Wootz steel making was almost stopped. Similar fate was of zinc production also.

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Exercises

1. Which materials were used to make the colour of inks?
2. How was the concept of atom described in early Indian philosophical system?
3. Justify that copper metallurgy in India has indigenous origin.
4. What makes the extraction of zinc difficult? How did the Indian smelters carry out the process of smelting of zinc?
5. How can one show that the smelters and smiths of Indian sub-continent had advanced knowledge of copper metallurgy?
6. What caused the decline of knowledge of metallurgical skills in India?
7. Why iron pillar of Delhi has not rusted even after exposure to moist air for so many years?

Extended Activities

- Collect information about the methods used to purify zinc in ancient time and today.
- Collect pictures and documents related to the historical background of two rust resistant monuments erected in India.
- Collect information about ancient Indian knowledge in the field of cosmetics.
- Collect information about ancient Indian knowledge in the field of drugs.

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Glossary

Alchemy—The medieval forerunner of chemistry, concerned particularly with attempts to convert base metals into gold or to find a universal elixir.

Faience—An attractive glazed ceramic or stone with lustrous sheen.

Iatrochemistry—Chemistry combined with medicine. It is a school of thought of the sixteenth and seventeenth centuries which stressed the use of chemicals in the treatment of diseases.

Metaphysics—The branch of philosophy the objective of which is to determine the real nature of things.

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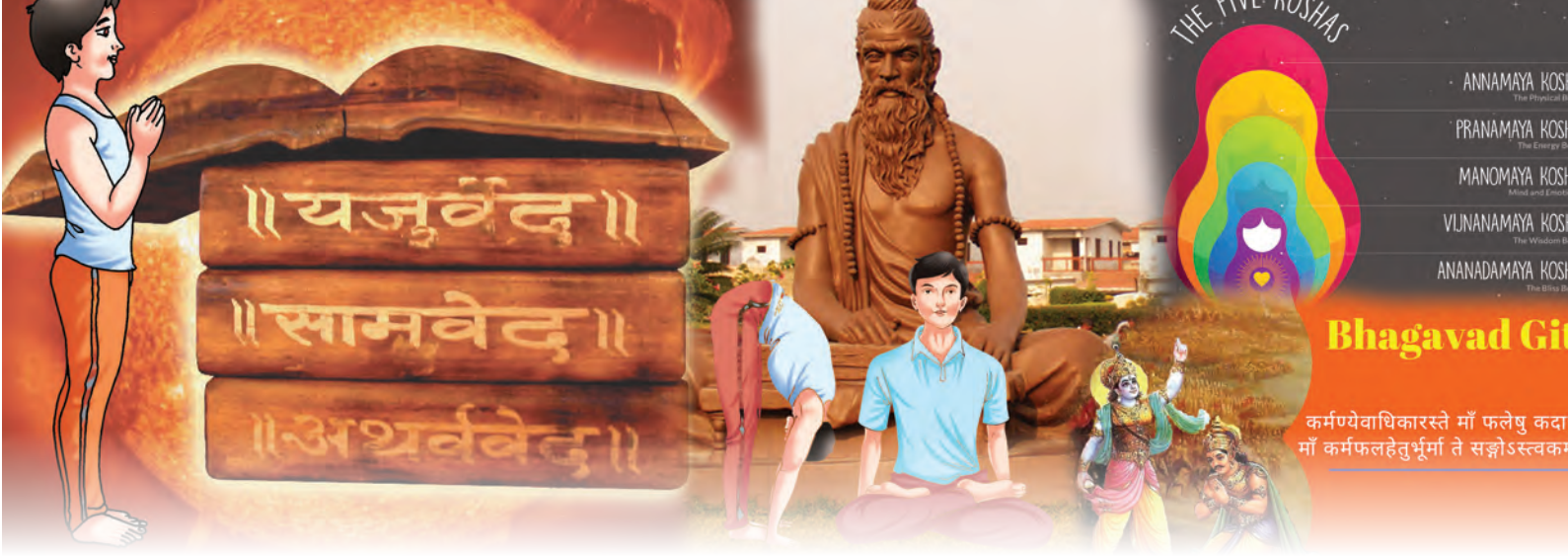

Yoga

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Yoga is an ancient Indian wisdom and it is our cultural and spiritual heritage. Yoga essentially focuses on bringing harmony between body and mind, thought and action; restraint and fulfilment; human and nature; a holistic approach to health and well-being. It is an art and science of healthy living. Yoga is also 'anuśāsanam' (discipline) which helps to develop overall physical, mental, spiritual, and social aspects of an individual's personality. To accomplish this, it advocates practice of different yogic techniques like *Āsana* (psycho-physiological postures), *Prāṇāyāma* (breath regulation techniques), *Pratyāhāra* (withdrawal of senses) *Dhāraṇā* (concentration) and *Dhyāna* (meditation), etc.

In modern world, there is a general notion among the masses that Yoga is a series of exercises called *āsana* and considers it for their physical fitness and wellness. But it is not so. So, one need to understand that Yoga is not just related to physical fitness and wellness movement as it is perceived today, but it is a way to lead a holistic life and to attain enlightenment. There are various schools of Yoga, namely *Jñāna-yoga, Bhakti-yoga, Karma-yoga, Pātañjala-yoga* and *Haṭha-yoga,* etc., while *āsana* is just one limb of *Aṣṭāṅga-yoga* and *Haṭha-yoga.*

Etymology of Yoga

The word 'Yoga' is derived from the Sanskrit root *Yuj*, meaning 'to join' or 'to yoke' or 'to unite'. As per Yogic scriptures, the practice of Yoga leads to the union of an individual consciousness with that of the universal consciousness,

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Maharishi Patanjali

Source: https://encrypted- tbn0.gstatic.com/ images?q=tbn:ANd9GcRqpHHuNS58HyMQZ0wbKFAojuvjc1kA1p4AAZpfobKdaWdGtxjj

indicating a perfect harmony between the body and mind, human and nature. According to modern scientists, everything in the universe is just a manifestation of the same quantum firmament. One who experiences this oneness of existence is said to be in Yoga, and the practitioner is termed as a yogi, having attained a state of freedom referred to as *mukti*, *nirvana* or *mokṣa*.

History and Development of Yoga

The practice of Yoga is believed to have started with the very dawn of civilisation. The science of Yoga originated thousands of years ago, long before the first religious belief systems were born. Yoga believes that suffering is a fact and *avidyā* (ignorance) is the root cause of all sufferings. Yoga has originated and been developed by ancient Indian *rishis* to overcome all kinds of suffering of human beings and its root cause. Yogic practices lead to health, harmony and total freedom. The *ṛṣis* and sages carried this yogic knowledge to different parts of the world including Asia, the Middle East, Northern Africa and South America.

Archaeological findings such as Yogi-like figure engraved on soapstone seal verified the existence of Yoga culture which is beyond 5000 years. Thus the history of Yoga can be traced back to over 5000 years. The history and development of Yoga can be divided into following periods.

Carving on Stones of Yoga Mudrā During Indus Valley Civilisation

Source: https://i.pinimg.com/originals/ac/e4/39/ ace4397b7 3271e969fe1bbf42e03d473.jpg

Pre-Vedic Period

The history of Yoga can be traced back to pre-vedic period. The study of the history of Indus Valley Civilisation reveals that the practices of Yoga was one of the significant features during that period. Yoga is being widely considered as an 'immortal cultural outcome' of Indus Sarasvati Valley Civilisation—dating back to 2700 B.C., it has proved itself catering to both material and spiritual upliftment of humanity. The stones seals excavated from the sites of the Indus Valley Civilisation depicting figures in yogic postures indicated that Yoga was being practised even during 3000 B.C. The idol of Pashupati in yogic postures is one of such specimens.

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Vedic and Upanishadic period

This period is marked with the emergence of *Vedas*.

There are four *Vedas*:

(i) *Ṛgveda*
(ii) *Sāmaveda*
(iii) *Yajurveda*
(iv) *Atharvaveda*

During this period, the people relied on the knowledge of dedicated vedic yogis (*rishi*) to teach them how to live in divine harmony. The *ṛṣis* (*seers*) were also gifted with the ability to see the ultimate reality through their intensive spiritual practices. The *vedas* contain the oldest known *yogic* teachings called *Vedic Yoga*.

Script from Vedas

Source: https://www.hindujagruti.org/wp-content/uploads/2014/09/1217775786_4_vedas.jpg

Activity

1. Collect the photographs of yogis in the classical period and prepare a collage.
2. Write a note on the development of Yoga.

The *Upaniṣads* are the concluding portion and essence of the *Vedas*. The *Upaniṣads* are contained in the knowledge portion of Vedas. The concepts of yoga are widely available in the Upanishads. The Yoga in *Upaniṣads* describe the inner vision of reality resulting in intense self-inquiry. Jñāna-*yoga*, *Karma-yoga* and *Dhyāna-yoga* are the main outcomes of the Upanishadic teachings.

Classical period

In the pre-classical era, Yoga was an incoherent mixture of various ideas and techniques that often contradicted each other. The classical period is defined by Maharshi Patanjali's *yoga sutras,* the first systematic presentation of Yoga. After Patanjali, many sages and Yoga masters contributed greatly for the preservation and development of the field through their well-documented practices and literature. The period between 500 B.C.–A.D. 800 is considered as the Classical period, which is also considered

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Pancha mahavrata of Mahavir

1. Non-violence—Live the life with the promise of not even drinking small creatures.
2. Truth—Never lie, no matter how much difficulty comes to their life.
3. Renunciation—They do not carry any kind of property and do not collect anything.
4. *Asteya*—No stealing
5. *Brahmacarya*—Jain ascetics have to follow celibacy completely.

Eightfold Path of Buddha

1. Right understanding (*Sammā Diṭṭhi)*
2. Right thought (*Sammā Saṁkappa*)
3. Right speech (*Sammā Vāca*)
4. Right action (*Sammākammanta*)
5. Right livelihood (*Sammā Ājīva*)
6. Right effort (*Sammā Vāyāma*)
7. Right mindfulness (*Sammā Sati*)
8. Right concentration (*Sammā Samādhi*)

as the most fertile and prominent period in the history and development of Yoga. During this period, commentaries of Vyāsa on *Yoga Sūtras* and Bhagavad Gītā, etc., came into existence. This period can be mainly dedicated to two great religious teachers of India—Mahavir and Buddha. The concept of five great vows—*Pañcamahāvrata* by Mahavir and *Aṭṭhaṁgika Magga* or eightfold path by Buddha can be well considered as early nature of *Yogasādhana*. We find more explicit explanation of Yoga in Bhagavad Gītā, which has elaborately presented the concept of *Jñāna-yoga, Bhakti-yoga* and *Karma-yoga*. These three types of Yoga are still the highest example of human wisdom. Patañjali's *Yoga sūtra* besides containing various aspects of Yoga, is mainly identified with the eight fold path of Yoga. Vyasa wrote a very important commentary on *Yoga sūtra*. During this very period, the aspect of mind was given more importance and it was clearly brought out through *Yoga Sādhanā*. Mind and body both can be brought under control to experience equanimity. Patañjali described 'eight limbed path' in order to attain *Samādhi* or enlightenment.

Yama (Restraint) and _Niyama_ (Observance)

Yama and *Niyama* are principles which need to be adopted always in our day-to-day life. These can be considered as the universal codes of conduct that help us in following high standards in our personal and social life. Principles of *yama* are concerned with one's social life; *Yama* and *niyama* are parts of *Aṣṭāṅga yoga*.

The five principles of Yama are: *Ahimsa* (non-violence), *Satya* (truthfulness); *Asteya* (non-stealing); *Brahmcarya* (abstinence) and *Aparigraha* (non-collectiveness).

The five principles of *niyama* are: *Śauca* (cleanliness); *Santoṣa* (satisfaction); *Tapas* (austerity); *Svādhyāya* (study of good literature and knowing about the 'self') and *Iśvarpraṇidhāna* (dedication to the God or Supreme power).

Activity

1. Prepare a report on evolutionary changes that have occurred in Yoga.
2. Collect information about the main Yoga Gurus who spread Yoga to the world.

- *Yama*: Social restraints, observances or ethical values
- *Niyama*: Personal observances of study, purity and tolerance.
- *Āsana*: Psycho-physiological postures

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- *Prāṇāyāma*: Control of life force through breath control or regulation
- *Pratyāhāra*: Withdrawal of senses
- *Dhāraṇā*: Concentration
- *Dhyāna*: Meditation
- *Samādhi*: Spiritual absorption

Post classical period

The period between A.D. 800–A.D. 1700 has been recognised as the Post Classical period, wherein the teachings of great Acāryatraya Adi Śaṅkaracārya, Rāmānujācārya, Mādhavācharya were prominent during this period. The teachings of Suradāsa, Tulasīdāsa, Purandaradāsa and Mīrabāī were prominent during this period. The *Nātha Yogis* of *Haṭha Yoga* tradition like Matsyendranātha, Gorakṣanātha, Caurangiṅātha, Svātmarāma Suri, Gheraṇḍa, Śrīnivāsa Bhaṭṭa are some of the great personalities who popularised the *Haṭha Yoga* practices during this period.

This period is different from the first three since its focus is more on the present. At this point, we see a proliferation of literature as well as the practice of Yoga. A few centuries after Patañjali, a number of Yoga masters created a system of practices designed to rejuvenate the body and prolong life. They embraced the concept of physical body as the means to achieve enlightenment.

Yoga in modern period

The period between A.D. 1700–1900 is considered as modern period. This was the time in which great legacy of Yoga teachings was carried forward by prominent Yoga personalities like Ramaṇa Maharṣi, Rāmakṛṣṇa Paramahaṁsa, Paramahaṁsa Yogānanda, Swami Vivekānanda, Swami Dayānanda Sarasvatī and Sri Aurobindo. Their philosophies, traditions, lineages and *Guru-śiṣya paramparā* led to further the knowledge and practices of different Traditional Schools of Yoga, e.g., *Jñāna-yoga, Bhakti-yoga, Karma-yoga, Rāja-yoga, Haṭha-yoga* and Integral-yoga, etc.

Yoga in contemporary period

Now in the contemporary times, everybody has conviction about Yoga practices towards the preservation, maintenance and promotion of health. Yoga has spread all over the world by the teachings of great personalities like Swami Shivananda, Shri T. Krishnamacharya, Swami Kuvalayananda, Shri

Swami Vivekananda

Source: http://veda.wdfiles.com/local-files/vivekananda/vivekananda_poster.jpg

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Yogendara, Swami Rama, Maharshi Mahesh Yogi, Pattabhi Jois, B.K.S. Iyengar, Swami Satyananda Sarasvati and the like.

In the present scenario, Yoga has been accepted by the world as a boon to prevent lifestyle diseases and for stress management. Given the health problems being at the centre stage of challenges faced by world population, Yoga is considered mainly as a tool of physical and mental well-being.

Considering the importance and potential of Yoga in health and well-being, the United Nations General Assembly (UNGA) on 11 December 2014 approved the proposal of the honorable Prime Minister of India, urging the world community to adopt an International Day of Yoga. The 193 members of UNGA approved the proposal by consensus with the record of 177 co-sponsoring countries, a resolution to establish 21st June as International Day of Yoga. This is the biggest recognition for Yoga by world community. On December 1, 2016, UNESCO inscribed Yoga in its list of intangible cultural heritages of humanity. *Yoga Sadhana* of all hues and colours is considered panacea for a meaningful life and living. Its orientation to a comprehensive health, both an individual and social, makes it a worthy practice for the people of all religions, races and nationalities.

Now-a-days, millions of people across the globe irrespective of their age, gender, cost, religion and countries have been benefitted by the practice of yoga which has been preserved and promoted by the great eminent yoga masters from ancient time to this date. Yoga has united the world and brought the whole world under one umbrella to live in peace and harmony.

Traditional Schools of Yoga

The different philosophies, traditions, lineages and *guru-śiṣya paramparā* of Yoga led to the emergence of different traditional schools.

Jñāna Yoga

Jñāna means 'knowledge'. *Jñāna-yoga* is the yoga of wisdom. It shows the path of self-realisation through discerning the real from the unreal and discrimination between right and wrong. The three stages of *Jñāna-yoga* practices are considered as *śravaṇa, manana* and *nidhidhyāsana.*

- *Śravaṇa*: listening or absorbing the instruction.
- *Manana*: reflection or contemplation involving reasoning and arriving at intellectual convictions.
- *Nidhidhyāsana*: repeated meditation and implementation of conviction or attaining to oneness with reality.

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Bhakti Yoga

Unconditional and intense love for God is Bhakti. Bhakti Yoga is a Yoga of devotion. *Bhakti Yoga* may be defined as the pathway of devotion to the realisation of personal God. The nine primary forms of bhakti (*Navadhā Bhakti*) are—(1) *śravaṇa* ('listening' to the scriptural stories of Kṛṣṇa and his companions), (2) *kīrtana* ('praising,' usually refers to ecstatic group singing), (3) *smaraṇa* ('remembering' or fixing the mind on Viṣṇu), (4) *pāda-sevana* (rendering service), (5) *arcana* (worshiping an image), (6) *vandana* (paying homage), (7) *dāsya* (servitude), (8) *sākhya* (friendship), and (9) *ātma-nivedana* (complete surrender of the self). These nine principles of devotional service are described as helping the devotee remain constantly in touch with God. Bhakti softens the heart and removes jealousy, hatred, lust, anger, egoism, pride and arrogance. It infuses joy, bliss, peace and knowledge.

Karma Yoga

Karma means action. *Karma Yoga* is the path of selfless action intended to overcome the desire which is the root cause of all miseries or sufferings. It purifies the action and emotions of the aspirant to act selflessly without the thought of any personal gain rewards. By having this state of mind—detaching from the fruit of action and surrender to the God, one can learn to sublimate and overcome the ego. The culmination of *Karma* Yoga lies in the devotee's diligent performance of his duty and offering the results thereof to the God.

Pātañjala Yoga

The aim of *Pātañjala Yoga* (popularly called 'Raja Yoga') is to attain *citta-vṛtti-nirodha* (cessation of mental modifications), leading to *kaivalya* (self-realisation). It is the Yoga for mind management and to realise the self by the process of *dhayana* (Meditation). Yoga of Patanjali, popularly known as 'Aṣṭāṅga-Yoga', aims at restraining mental modification to realise the self. As explained earlier, these eight limbs include *Yama, Niyama, Āsana, Prāṇāyāma, Pratyāhāra, Dhāraṇā, Dhyāna* and *Samādhi*. Practice of *Aṣṭāṅga Yoga* develops both personal and social dimensions of one's personality.

Haṭha Yoga

Haṭha Yoga is the yoga of establishing balance between pairs of opposite. The roots of *Haṭha Yoga* are traced in *Tantra*.

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Depicting a gross body of human being showing layers of existence.
Source: http://eddy-gonzales.de/wp-content/uploads/2018/09/kosha-aufbau.png

The word *Haṭha* is the combination of *Ha* (sun) and *Tha* (moon) also represent the *Īda* (left) and *Piṅgala* (right) Nāḍīs present in our body. Nāḍīs are channels of energy in the body. *Piṅgala* is known as the right channel and *Idā* is the left energy channel. *Haṭha Yoga* includes the yogic practice of *Ṣat-karma, Āsana, Prāṇāyāma, Mudrā, Pratyāhāra, Dhyāna, Samādhi,* etc. The main objective of Haṭha-yoga is to have a healthy body and mind to accomplish the goal.

Foundations of Yoga

As per the insight of ancient texts, human body is made up of gross body (*Sthūlaśarīra*), subtle body (*Sūkṣmaśarīra*) and the casual body (*Kāraṇaśarīra*). Also there is a mention of five layers (*Pañcakoṣas*) of existence in *Taittirīya upaniṣad* and these are *Annamaya* (physical), *Prāṇamaya* (energy), *Manomaya* (mental), *Vijñānamaya* (intellectual) and *Ānandamaya* (blissful) *Koṣa*.

Annamaya makes the structural framework for Sthūla-*śarīra,* whereas, *Prāṇamaya*, *Manomaya* and *Vijñānamaya is* for *Sūkṣma-śarīra* and *Ānandamaya-koṣa* for *Kāraṇa-śarīra.*

Annamaya Koṣa or koṣa made of food or the food body

This is the outermost superficial sheath (cover) and is represented by our physical body made up of the five elements and is constituted by the food that we eat. *Kriyā, Āsana* and *Prāṇāyāma* helps in the strengthening of this sheath.

Prāṇāyāma Koṣa or the energy body

This is the *pranic* sheath which energises or invigorates all the other sheaths. It is responsible for all the physiological and mental functions. It is mapped onto the physical body and extends slightly beyond the physical body. Our breath or *prāṇa* is the bridge between the body and mind. *Prāṇāyāma* practice strengthens the *prāṇayamakoṣa.*

Manomaya Koṣa or the mental body

This is the sheath of our thinking, feeling and emotions. It is comprised of *manas, ahaṁkāra* and the lower *buddhi. Prāṇāyāma* and *Pratyāhāra* (control over the senses) practices cater to this *koṣa.*

Activity

Prepare a chart or model on *Aṣṭāṅga Yoga* showing the eight limbs.

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Vijñānamaya Koṣa or the wisdom, higher intellect body

This is the region where refined or higher level thinking and intuition starts happening. Meditation practices cater to this sheath.

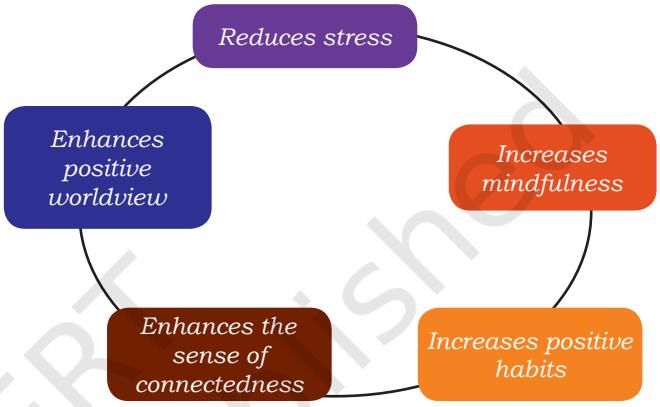
Ānandamaya Koṣa or the bliss body

This sheath is the closest to our self. Transcending the body, mind and intellect leads to bliss. Meditation is the practice for this sheath.

Yoga and Holistic Health

When we discuss about health, it is not merely the absence of diseases or illness at the physical level but also psychological, emotional, social and spiritual planes. Yoga believes in identifying the root cause of a disease and its elimination at all levels.

For the holistic development of overall health, Yoga works at several planes of human being:



Physical

Āsanas primarily work at the physical level. Those practices tone up the muscles, nerve fibres, enhances blood circulation, promote the physiological functions and set the internal environment of the body called homeostasis. The *Kriyā* (cleansing techniques) vitalises the internal organs of the body and restore their efficiency by eliminating the toxic matter from the body. They establish equilibrium between *vāta* (air), *pitta* (bile) and *kapha* (phlegm). To nourish the physical body, a pure balanced wholesome diet with the supplement of nutrients is required. Yogic diet nourishes the body. Yogic food which is often discussed in the ancient text is *sātvika* food. Yoga emphasises on *mitāhāra*, which is related to the quality and quantity of food and also the state of mind during the intake of food. Various *āsana* or *yogic* postures also help in physical development.

Cognitive or Intellectual

Mental development is the growth and change in cognitive processes such as attention, memory, thinking, perceiving and imagination, reasoning and problem-solving. Practising of Yoga including *Āsanas*, *Prāṇāyāma* and *Yoga nidrā* by the students, has been found to improve their memory

Activity

Make a file and paste pictures on different *Asanas*, *Pranayamas* and *Kriyas*.

- Write their steps and benefits on health.
- Write do's and don'ts of each of them.
- Collect pictures from different sources about various asanas. Place those pictures on a chart paper. Discuss with a large group in your class.

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significantly. Meditation plays a vital role in regulating the speed of thoughts and attains the calm, quiet and relaxing state of mind. Meditation is a key tool to calm down the mind and hence becomes an important key for helping in managing the stress.

Activity

How Yoga plays an important role in one's personality development? Discuss.

Emotional

Emotions are an integral part of human life. Emotional development can be considered in terms of control and expression of emotion as well as management of relationalships with oneself and others. There is always a fight between our likes and dislikes, and positive and negative emotions. Negative emotions are so vibrant in the mind that seldom any positive thought gets sharpened up in our psyche. Some *Āsanas*, *Prāṇāyāma* and relaxation techniques are good tools for conditioning the autonomous nervous system. These *yogic* practices have been found to bring significant positive changes in the emotional states of anxiety, stress, depression, regression, fatigue, guilt, and arousal. *Bhakti yoga* (unconditional love) is the well accepted method for culturing our emotions and get our mind directed towards accepting the positive emotions.

Social

Due to isolation, an individual develops varieties of psychosocial complications. *Yamas* and *Niyamas* can be important tools for social development. During *satsang*, one comes near the Guru and acquaints with positive mentors and companions for life. Healthy social contacts, interpersonal relationships make life enjoyable and free from physical and psychological strains.

Spiritual

Spiritual development takes place in the form of habits, values and ethics, etc. Good habits and strong value system inculcated right from the childhood will have lasting effects on the personality of the child. For spiritual development, *yama*, *niyama*, *pratyāhāra* and *dhyāna* (meditation) are helpful. *Yama* and *niyama* help to develop our moral values while *prāṇāyāma* and meditation help us to realise our true self. Introspection is very effective for the development of 'self'.

Yoga and Human Values

Values are the principles that an individual adopts in one's life which describe human behaviour. Values are the desirable ideals and goals, which are intrinsic and when achieved, in fact, evoke a deep sense of fulfilment.

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Activity

In Column I, put a list of *Yamas* and *Niyamas* that you observe in day-to-day life and in Column II put those *Yamas* and *Niyamas* that you consider to be observed.

Questions

(a) Compare both the columns. Do the *Yamas* and *Niyamas* given in Column I tally with *Yamas* and *Niyamas* in Column II?
(b) Do you think that you need to change?
(c) Make a separate list indicating which one from the list (Column I) you want to change.

Column I	*Column II*

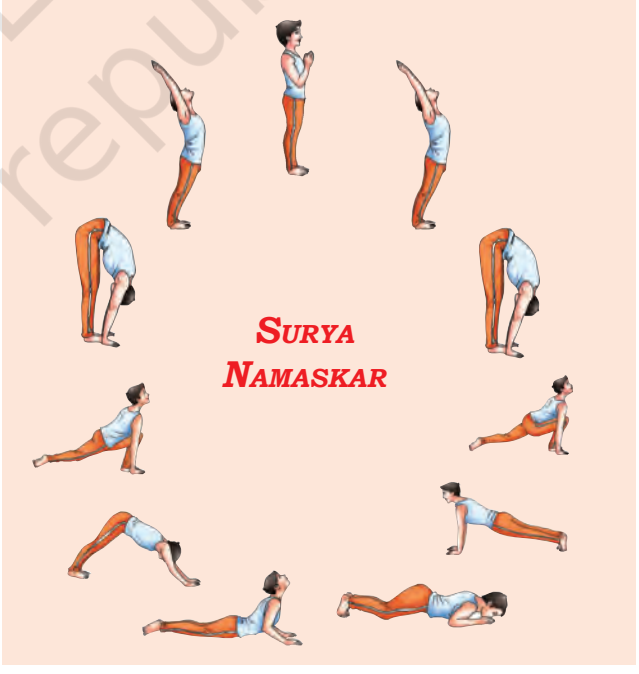
Values such as truth, non-violence, peace, love, honesty, generosity and no greed are given highest importance in Yoga. The erosion of human values becomes the primary cause for corruption, terrorist activities, violence, unrest and various complications in the society. Modern education is for bread earning purpose and does not focus on the development of spiritual, moral and ethical values. Indian culture is deeply rooted in spiritual and ethical values; unless these values find their way into the life of students, education will lose its significance and will not fulfil its aim. In order to progress in the spiritual dimension, one has to adopt the following values that go in line with Indian tradition and heritage.

Application of Yoga Practices*

Yogic practices are mind centric and help in good health and wellness. You have learned the *yogic* practices in your earlier classes. These practices are given here in brief.

Kriyā

These are detoxification procedures that are clinical in nature and help to remove the toxins accumulated in the body. For example, *Jala Neti, Sūtra Neti, Dhauti, Trāṭaka* and *Agnisāra*, etc.



Postures of Surya Namaskar

*All practices have already been discussed in the textbook prepared for upper primary and secondary stages, titled *Yoga: A Healthy Way of Yoga of Living*. Yoga related practices are also included in the textbook *Health and Physical Education* for Classes IX–XII.

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Standing Posture: Trikoṇāsana

Sitting Posture: Vajrāsana

Prone Posture: Bhujaṃgāsana

Supine Posture: Pawanamuktāsana

Sūrya Namaskāra

Sūrya means 'sun' and *namaskāra* means 'salutation' or 'bowing down'. It consist of 12 postures. The regular practice of *sūrya namaskāra* helps improve blood circulation throughout the body and maintain health, and thereby helps one to remain disease-free.

Āsana

We all know that *āsanas* are beneficial for our physical and mental development. You have also learnt many *āsanas* in the previous classes. Now, we will discuss some more *āsanas* in this section.

Standing Posture

Pāda-hastāsana, Garuḍāsana, Trikoṇāsana and *Kaṭicakrāsana*

Sitting Posture

Padmāsana, Vajrāsana, Svastikāsana, Pascimottānāsana, Uṣṭrāsana, Ākarṇa Dhanurāsana, Vakrāsana, Supta Vajrāsana, Gomukhāsana, Maṇḍūkāsana and Uttānamaṇḍukāsana

Prone Posture

Bhujaṅgāsana, Śalabhāsana, and *Dhanurāsana*

Supine Posture

Setubandhāsana, Pavanamuktāsana, Sarvaṅgāsana, Halāsana and *Matsyāsana*

Bandha and *Mudrā*

These practices are associated with *prāṇāyāma*. These further facilitate the control over the mind. These include *Uḍḍīyana Bandha, Yoga Mudrā* and *Brahma Mudrā.*

Prāṇāyāma

It helps in developing the awareness of vital basis of one's mind and helps to establish control over the mind. Different types of *Pranāyāma* include *Anuloma-viloma Prāṇāyāma, Bhastrikā Prāṇāyāma, Śitali Prāṇāyāma and Bhrāmarī Prāṇāyāma.*

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Activity

Find out from different sources about the following asanas:

- *Pārśvakonāsana*
- *Viparītakaraṇi*

Dhāraṇā or Dhyāna

Five minutes on body awareness and five minutes breathe awareness and practice of meditation lead towards self-realisation. By practicing of *Dhyāna,* one can take the mind away from all the negative things and helps to improve the functioning of mental abilities.

Conclusion: Yoga practices have numerous benefits that positively affect us physically and mentally. Yoga works as follows:

Kriyās, Āsanas, Prāṇāyāma and *Dhyāna*
↓
Balance Endocrinal and Nervous control
↓
Increases Mind and Body Control
↓ ↓ ↓
Calm Relax Refresh
↓
Health and Harmony

Yoga is the perfect lifestyle as it is comprehensive and holistic in nature. *Yogic* principles of lifestyle help to strengthen and develop positive health enabling us to withstand stress better. This *Yogic* 'health insurance' has been achieved by normalising the perception of stress, optimising the reaction to it and releasing the pent-up stress effectively through the practice of various *Yogic* practices. Thus, Yoga is proving to be the most desirable complimentary and traditional system of healthcare in the present scenario.

Protocol of Yoga

The proper protocol of Yoga practice for healthy living shall be as follows:

- Detoxification (*Śodhana*)
- Diet Modification (*Āhāra*)
- Postural Modification (*Āsana*)
- Breath Modification (*Prāṇāyāma*)
- Relaxation (*Vihāra*)
- Concentration (*Dhāraṇā*)
- Meditation (*Dhyāna*)
- Behavioural Modifications (*Vyavahāra*)

Anulom-Viloma Pranayama

Kapālabhāti Kriyā

Uḍḍiyana Bandha

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Exercises

Fill in the blanks

1. *Asteya* means_____.
2. Yoga is derived from the Sanskrit root word_____.
3. International Day of Yoga is being celebrated on_____.
4. Human body is made up of gross body,_____and causal body.
5. *Yamas* are_____.
6. *Niyamas are*_____.
7. *Jñāna Yoga* is the *Yoga* of_____.
8. Meaning of *Svādhyāya* is_____.
9. *Prāṇāyāma Koṣa* is the bridge between _____ and _____.
10. Patañjali *Yoga* is also known as_____.

Answer in one word

1. Who is the author of *Yoga Sūtra*?
2. Write the meaning of word 'Yuj'.
3. What is the aim of Yoga?
4. Write down the four names of traditional school of Yoga.
5. Write down two objectives of Yoga.
6. Write down the three names of *śaṭkarma* (cleansing) practices.
7. Write the names of *vedas*.
8. Write the three names of modern practitioners of Yoga.

Write short notes (100 words)

1. Describe *Pañcakoṣa*.
2. Write down the objectives of Yoga.
3. Discus the role of Yoga in holistic health.
4. Describe *Yamas* and *Niyamas*.
5. Write a short note on the history and development of Yoga.
6. Write a short note on the traditional school of Yoga.
7. Explain about the misconceptions of Yoga.
8. Describe *Aṣṭāṅga Yoga*.
9. Describe the stages of *Jñāna Yoga*.
10. Write down the nine primary forms of bhakti (*Navadha Bhakti*).
11. Write a short note on *Haṭha Yoga*.

Activities

1. Prepare a chart on *Yogāsana*.
2. Write a short biography on Maharṣi Patañjali.
3. Make a report on the modern Yogis who have contributed in the development of Yoga.

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